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Review Article

Review on Phytochemicals and Pharmacological Profile of *Helicteres isora* Linn.

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ABSTRACT
Most indigenous medicinal plants to cure specific ailments from ancient time traditionally. *Helecteres isora* Linn. (Sterculiaceae) also called as Marodphali, Marorphali, Avartani, and Enthanietc due to screw like shape of fruit commonly known as Indian screw tree possess therapeutic, phytochemical and pharmacological valued medicinal plant in South- East Asia. The present review is an attempt to provide brief scientific rationale of plants used in treatment of various diseases. The presence of flavones, triterpenoids, phytosterols, saponin, sugars flabotanins and cucurbitacin. The roots and barks possess antioxidant, antimicrobial and antispasmodic properties useful in hypoglycemic, expectorants, demulcent, and snake bite. The fruits used in treatment of griping bowels and diarrheal infection in new born baby. Acetone fruit extracts of H. isora has strong antioxidant and cytotoxic activity than other solvent extracts. The review revealed that the fruits are antioxidants and antimicrobial activities but so far no information on antispasmodic activity hence attempt was made to find out phytochemical contents for the same activity.

KEYWORDS
Helecteres isora, antioxidant, antispasmodic, antidiabetic, anticancer activity.

1. INTRODUCTION

In India various part of several medicinal plants are useful for treating different type of diseases. Helecteres isora is important medicinal plant of various Indian system of medicine like Traditional Siddha and Modern system of medicine. *Helecteres isora* is shrub or plant belongs to family Sterculiaceae commonly called as Indian screw tree. *Helecteres* means twisted, helical or spiral and isora is the name of boys meaning God of the seashore in Japan.[1]The plant has large genus consist of 45 species distributed in small tree or large shrub found in Asia including Indian Subcontinent, South China, Malay Peninsula, Java[2] and Saudi Arabia. Also, found in Australia. It is a tropical Asian shrub or medium-sized tree. The shrub/plant is found all throughout India from Punjab to Bengal; Jammu to South

India and Pakistan, Nepal, Myanmar, Thailand, and Sri Lanka. However, it gregariously grows in dry deciduous forests of central and western India up to 1500m on the hill slopes.[3][4][5]

Name of plant in different Language

Sanskrit – Avartani, avartphala, Murva,

- Hindi – Marorphali Marodphali, Enthani, Gomathi bhendu, jonkphal
- English - Indian screw tree, East Indian screw tree, deer's horn
- Marathi - Kewad, muradsheng
- Bengali –Antamora[6]
- Gujarati – Maradashingh, Maradashinghi
- Kannada – Yedmuri, Pedamuri
- Telugu –Vadampiri

1.1. Species isora

The plant is small tree or shrub 5-15 feet in height [7], young branches and stem covered with stellate trichomes. Leaves are simple, alternate, and ovate; margin is serrate with 6-9 mm long petiole. Flowers are solitary or in sparse cluster with orange-red petals turn pale blue when old. Petals are closely hooked together [8].

The fruits are twisted like screw hence the name Indian screw tree, 5 cm long compound pods greenish brown ripen in March and cylindrical with 5 spiraly twisted carpels and stellate lignified hairs along with mucilaginous cavity. The mesocarp and endocarp consist of fibre. [9]

The follicle of fruit contains 15-20 seeds dark brown to black colour placed in row. When fruits ripen turns brown and twisted like corkscrew become untwine and seed scatter. [6]

Figure 1. Leaves of H. isora

Figure 2. Flowering Twig.

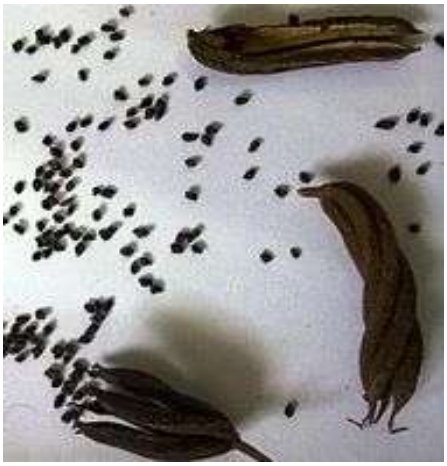


Figure 3. Dried Seed

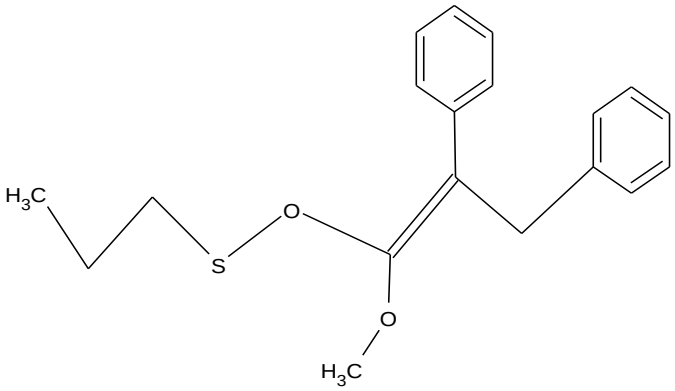
Figure 4. Immature Pod

2. Phytochemistry

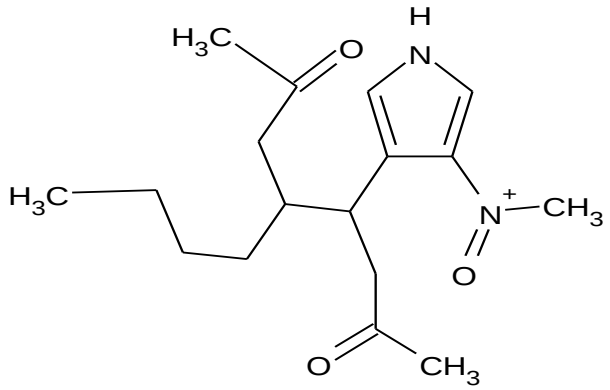
Table 1. Major bioactive compounds isolated from H. isora

Plant Parts	Bioactive compounds	Reference
Fruits	Helisterculins A and B, Helisorin Gallic acid, Caffeic acid, vanillin, p-Coumaric acid	[10]
	Carbohydrate, protein, fibre, mineral such as Calcium. Iron, Phosphorous	[11]
	Volatile oil, tannin, flavonoids, gums and mucilage	[2]
	Rosmarinic acid ,49- O-b -D-glucopyranosylrosmarinic acid, 4,49-O-di-b -D-glucopyranosylrosmarinic acid, 2R-O-(49-O-b -D-glucopyranosylcaffeoyl)-3-(4-hydroxyphenyl), lactic acid named as 49-O-b –D-glucopyranosylisorinic acid	[12]
	1 Methyl 4-methyl-2-(2'-nitrosophenyl)-5-oxo-5,7-dihydrofuro[3,4-b]pyridine-3-carboxylate 2. 3-(D-Galacto-penta-O-acetylpentitol-1'-yl)-4nitropyrrole 3. 3-(D-Manno-penta-O-acetylpentitol-1'-yl)-4nitropyrrole 4. Phenylcyclopentadienyl 5. Diphenyl r-2methoxycarbonyl-2,t-5-diphenylpyrrolidine-c-3,t-4-dicarboxylate 6. Docosanoic acid, 1,2,3-propanetriyl ester, 7. 2-Propenoic acid, 2-ethylhexyl ester, 8. Dimethylene-berberine. 9. Isoscutellarein 4′-methyl ether 8-*O*-β-D-glucuronide 6″-*n*-butyl ester 10. Isoscutellarein 4′-methyl ether 8-*O*-β-D-glucuronide 2″ 11. 4″-disulfate and isoscutellarein 8-*O*-β-D-glucuronide 2″,4″-disulfate.	[13] [14]
Leaves	Gallic acid, Caffeic acid, vanillin, p-Coumaric acid	[10]
	7,4^{1}di-O-methyl isoscutellarein (5,8-dihydroxy-7,4^{1}flavones) along with kaempferol-3-o-galactoside (trifolin) and herbacetin-8-o-glucoronide (hibifolin)	[15]

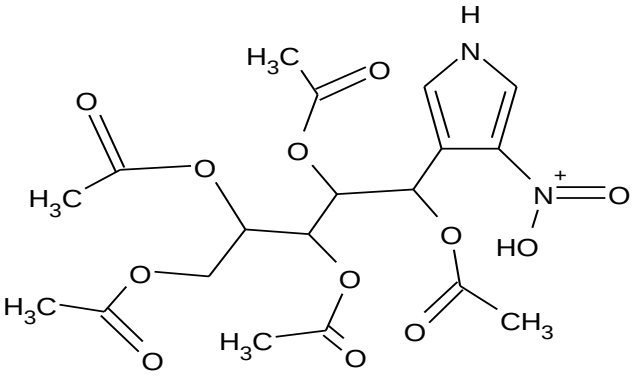
	Tetratricontanyl 1-tetratricontanoate, tetratricontanoic acid, tetratricontanol, sitosterol	[16]
Stem, bark	Pigments, phytosterol, hydroxyl carboxylic acid, orange-yellow colouring matter(carotenoids), saponin, phlabotaninis,sugar, lignin	[17]
Seed	Diosgenin	[18]
	Phytosterols, fixed oil, fats, phenolic compound, tannin, amino acid, carbohydrate	[19]
Root	cucurbitacin b, isocucurbitacin b	[20]
	β-sitosterol, betulic acid, oleanolic acid, daucosterol, isorin, 3 β27diacetoxylup20(29)en-28-oic methyl ester	[21]
	Catechol, Gallic acid	[22]



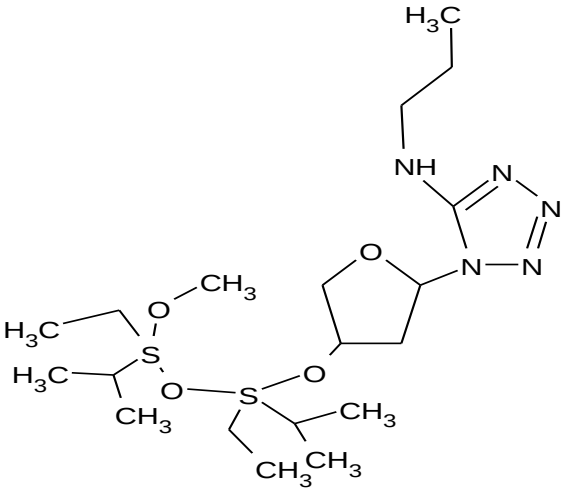
Structure 1. Methyl 4-methyl-2-(2'-nitrosophenyl)-5-oxo-5, 7-dihydrofuro[3,4-b]pyridine-3-carboxylate)



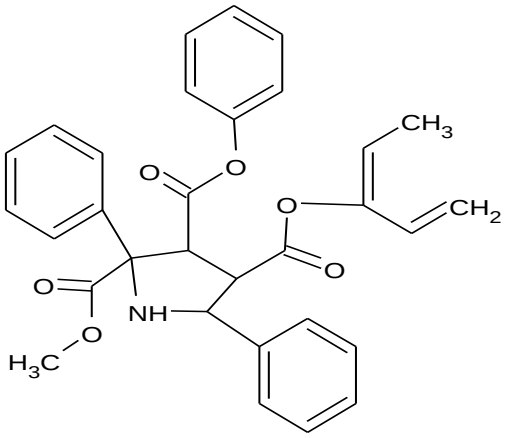
Structure 2. 3-(D-Galacto-penta-O-acetylpentitol-1'-yl)-4-nitropyrrole)



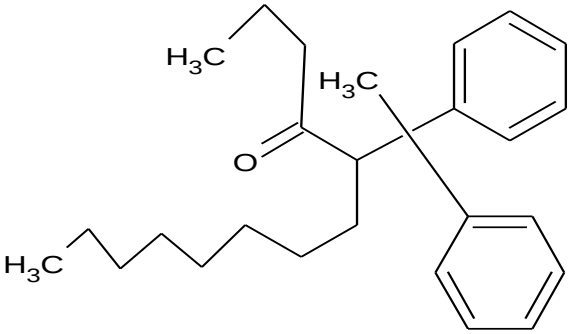
Structure 3.3-(D-Manno-penta-O-acetylpentitol-1'-yl)-4-nitropyrrole)



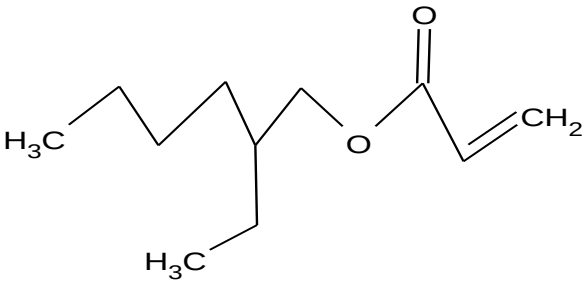
Structure 4. Phenylcyclopentadienyl



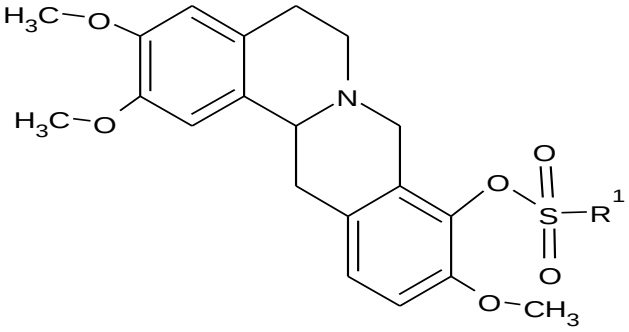
Structure 5. Diphenyl r-2methoxycarbonyl-2,t-5 diphenylpyrrolidine 4- dicarboxylate



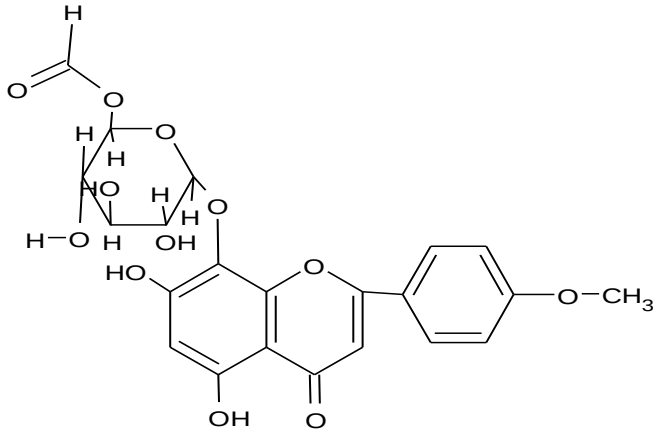
Structure 6. Docosanoicacids, 1, 2, 3-propanetriyl ester



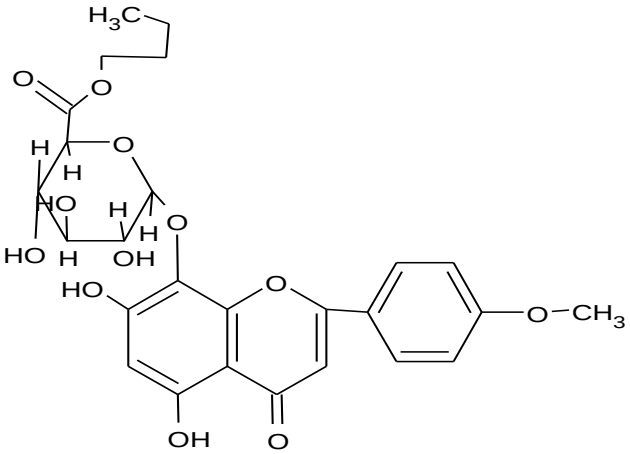
Structure 7. 2-Propenoic acid, 2-ethylhexyl ester



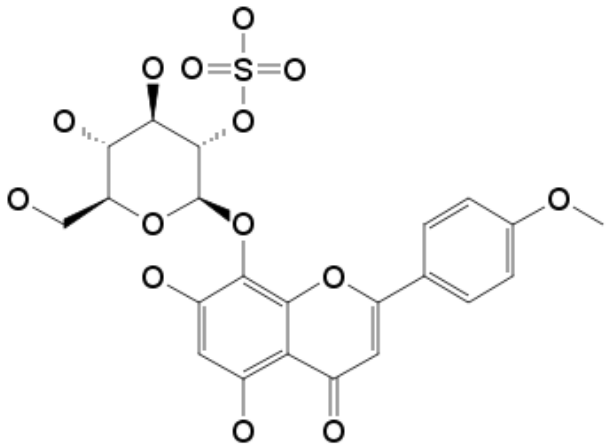
Structure 8. Dimethylene-berberine



Structure 9. isoscutellarein 4′-methyl ether 8-*O*-β-D-glucuronide 6″-*n*-butyl ester



Structure 10. isoscutellarein 4′-methyl ether 8-*O*-β-D-glucuronide 2″



Structure 11. 4″-disulfate and isoscutellarein 8-*O*-β-D-glucuronide 2″,4″-disulfate.

Table 3. Ethano-medicinal claims and their scientifically proved activities

Plant parts	Disease	Ethanobatany	Scientific basis	Experimental evidences
Bark	Diarrhea	Bark boiled with water taken orally thrice per day	Antimicrobial activity/ Antispasmodic action	[10][29][28][34]
	Diabetes	1 fresh fruits each taken orally	Antioxidant activity/ Anti- hyperglycemic and hypolipidemic effects Decreased level of glucose, glycosylated hemoglobin and plasma glycoproteins; Increase	[23][24][25] [26][29][30] [31][32][33]

			in levels of plasma insulin, hemoglobin	
	Gastrointestinal problems	Approx. 5 g fruit powder with salt is to be taken thrice daily with water	Antioxidant activity/ Antimicrobial effects	[10][25][26] [27][28][32][33]
Fruits	Weakness in new born baby	1) Fruit paste mixed with mustard oil and turmeric paste is used for massaging in new born baby to cure profound weakness. 2) Fruits are fried in mustard oil, used on new born baby to remove body pain.	Antioxidants activity / Antispasmodic action	[25][26][32] [33][34]
	Sores of ear	Fruits are made into liniment for sores of ear	Antioxidant activity/ Antimicrobial activity	[10][25][26] [27][28][32][33]
	Post-delivery weakness	Fruit powder along with other herbs and spice mixed sweet dish is given to women after child birth. It may be given to them during pregnancy	Antioxidant activity/ Antispasmodic action	[25][26][32] [33][34] [26][27][28][29] [25]
	Dysentery	5 g seed powder boil with water; taken twice a day	Antimicrobial activity for diarrhea and dysentery due to amoebiasis.	[10][27][28][34]
Seeds	Diabetes	Fresh root juice taken twice a day	Anti-hyperglycemic activity	[23][24][29][30] [31]

Roots	Cut and wounds is applied externally	Fresh root paste with turmeric paste is applied externally	Antioxidant activity/ Antimicrobial activity	[10][25][26] [27][28][32][33]
	Diarrhea	Root decoction	Antioxidant activity/ Antimicrobial activity	[10][25][26] [27][28][32][33]
	Scabies	Paste is applied externally twice per day till cure on infection area of scabies	Antimicrobial properties	[10][27][28]
Leaves	Skin infections	Fresh leaf paste applied thrice a day	Antioxidant activity/ Antimicrobial properties	[10][25][32][33]
	Snakebite	Fresh leaf paste applied on affected area	Free-radical scavenging activity might be playing an important role in inflammation	[10][25][32][33]

4. Pharmacological effects of Extracts of Helicteres isora Linn

4.1 Antidiabetic Activity

Ranjan Chakrabartiet al evaluate Helicteres isora L for antidiabetic antihyperglycemic and Hypolipidemic Activity, plant extract at various doses shows significant reduction in plasma glucose, triglycerides and insulin level in mice [35]

Aqueous bark extract of Helicteres isora L evaluated by M. Rajasekara Pandian et al in normal, glucose loaded and streptozotocin induced diabetic rats shows hypoglycemic effects.

Hypolipidaemic effect of extracts of Helicteres isora L streptozotocin (STZ) induced diabetic rats shows significant reduction in serum and tissue cholesterol, phospholipids, free fatty acids and triglycerides investigated by G. Kumar, and A. G. Murgesan[36]

Venkatesh et al. (2010) investigated restoration of pancreatic islets, kidney glomeruli, and liver to its normal size after treatment with root extract of H. isora.[10]

Saponins obtained from H. isora shows antidiabetic effects with activation of PI3K/Akt pathway, leading to phosphorylation and inactivation of GSK-3α/β with subsequent stimulation of glycogen synthesis as well as increase of Glut4-dependent glucose transport across the cell membrane [37]

4.2. Hepatoprotective Activity

Researchers have provided a scientific rationale for traditional use of these plants in management in liver diseases Alcoholic extracts of H. isora studied for hepatoprotective activity against carbon tetrachloride induced liver damage in rats. The blood sample clinically studied parameters serum total bilirubin, total protein, alanine transaminase, aspartate transaminase and

alkaline phosphatase activity. Result shows that total protein level significantly decreases in injured liver of rats.

Dhevi et al (2008) showed that ethanolic extract of H. isora bark in hepatotoxicity induced rats the total reversal and recovery of all parameter studied biochemical and antioxidant markers. [38]

Ethanolic extract of stem bark of Helicteres isora L showed that significant hepatocellular regeneration in carbon tetrachloride induced toxicity in rats were studied by K. Gayatri et al.[39]

The blood sample of rats was taken for biochemical studies previously induced liver toxicity and treated with ethanolic extract of root of Helicteres isora L potential reduction in total protein and serum marker. [32]

4.3. Antioxidant activity

The H. isora has potent action against free radical scavenging property due to presence of alkaloids and flavonoids. Kumar et al investigated antioxidant and anticancer activity of H. isora dried fruit extracts in various solvent extracts acetone extract showed strong cytotoxicity against human lung cancer cells by dot plate assay. [40]

Aqueous and alcoholic extracts from fruits and bark of H. isora are reported antioxidant activity such as free radical scavenging, toxicity to tumor cells, inhibiting nitric oxide and hydrogen peroxide radicals, and protection to normal cells when compared to standards Lascorbic acid, quercetin and rutin.[41-43]

Kumar et al reported that brain tissue was more susceptible to oxidative stress and increased lipid peroxidation in streptozocin diabetes. [44]

4.4. Anticancer activity

The fruit of H. isora methanolic extracts (50%) showed antitumor activity in melanoma cells but protected normal human blood lymphocytes.[33] Varghese et al reported that drug has potent action against human breast cancer their further plan is to isolate and evaluate active principles with probable mechanism of action.[45]

4.5. Antinociceptive activity

Phytochemicals analysis of drug shows that sterol, triterpenoids, glycosides responsible for pharmacological action. Sama Venkatesh et al obtained various extracts of root, petroleum ether, chloroform, ethanol, aqueous extracts shown significant antinociceptive activity on acetic acid induced writhing test in mice. [46]

4.6. Cardiotonic activity

H. isora has Cardiotonic activity due to Diosgenin compared with digoxin on isolated frog heart shows rapid onset of action. These studies confirmed that it is better option for digitalis. [47]

4.7. Hypolipidaemic activity

G. Kumar and et al investigated the hypolipidemic effect of aqueous extract of bark of Helicteres isora in streptozotocin induced diabetic rats at various doses. The significant reduction in the level of cholesterol, phospholipids, free fatty acid and triglycerides. [48]

4.8. Anti-diarrheal activity

The fruit has demulcent astringent and antispasmodic effect that are useful in the gripping of bowels and flatulence of infants and children. The bark, root and seeds are use in dysentery and diarrhea. [49]

4.9. Antimicrobial activity

Aqueous and alcoholic extract of fruit of Helicteres isora effective against a number of bacterial strains. The fruit aqueous extract of H. isora showed prominent antibacterial activities against E. coli, Staphylococcus epidermidis, Salmonella typhimurium, Proteus vulgaris, and moderate activity against Enterobacter aerogones, Staphylococcus aureus, and Salmonella typhi. S. Venkatesh et al reported antimicrobial activity of root extract of Helicteres isora. [50, 51]

4.10. Wormicidal activity

Pods are effective for killing the worms in children [52].

5. CONCLUSION

In the present review observed that different plant parts of Helecteres isora L. varied in phytochemical constituents. The above evidences show that each and every part of the medicinal uses having Antibacterial. Antidiabetic, Cardiotonic, anticancer activities. Various bioactivity studies of plant carried out. Only few studies shed no light on mechanism but the phytoconstituents from the extract showing activity still required to isolate, tested for bioactivity and formulated in to suitable herbal formulation alone or in combination with other drugs.

6. REFERENCES

1. Merriam Webster. Helicteres. USA: Merriam-Webster. [Online] Available from: http://www.merriam-webster.com/dictionary/ Helicteres. (2013).
2. Satake, T., Kamiya, K., Saiki, Y., Hama, T., Fujimoto, Y., Kitanaka, S. & Umar, M. (1999). Studies on the Constituents of Fruits of Helicteres isora L .Chemical and Pharmaceutical Bulletin-Tokyo. 47, 1444–1447.
3. Warrier, P. K., Nambiar, V. P. & Ramankutty, C. Indian medicinal plants: A compendium of 500 species (Vol. 3). Orient Blackswan. 132-135 (1994).
4. Ahuja B.S. Medicinal plants of Saharanpur (1965), 40-41.
5. Kirtikar K.R, Basu B.D. Indian medicinal plants. Vol. 1. Dehradun, India: International book distributors; 371–2(1995).
6. The wealth of India. Raw Materials, CSIR publication,5:25(1969)
7. Khory R.N. and Katrak N.N. Materia Medica of India and their Therapeutics, Neeraj Publication House 104(1981).
8. Kirtikar K.R. and Basu B.D. Indian Medicinal plants, published by Lalit Mohan Basu, edition 2nd 1:371(1975).
9. Chunekar K.C. Bhavaprakasha N. Varanasi: Chaukambha Bharati Academy, 27(2010).
10. Bean M.F, Antoun M, Abramson D, Chang C.J, Mc Laughlin J.L, Cassady J.M. Cucurbitacin B and Isocucurbitacin B Cytotoxic components of Helicteres isora. *J Nat Prod*. (1985)48.500-503.
11. Tibrewal R., (2017); Anti-Diabetic & Antioxidant Studies of Helicteres isora Roots. *International Journal of Pharmaceutical and Biological Science Archive* 5. 1. 23-29.

12. Sarkar M, Das G, Pathak S.K., Maitra S, Samanta A. (2013). Evaluation of in vivo wound healing and in vitro antibacterial activities of the different extract of Leucas indica Linn.; *Int J Pharm Pharm Sci,* 5.3.333-340 .

13. Elanchezhiyan C., Kumaravel K., Bilal Ahmad Bhat, Sethupathty S. (2014)Phytochemicals and Metabolite Fingerprinting of Helicteres isora Through Gas chromatography and Mass Spectrum analysis,*Journal of Pharmacy Research,*8.3.243-247.

14. Kamiya K, Saiki Y, Hama T, Fujimoto Y, Endang H, Umar M. Flavonoid glucuronides from Helicteres isora(2001)*Phytochemistry* 57.297–301.

15. Singh S. B., Singh A.H. And Thakur R., (1984) Chemical constituents of the leaves of H. isora; *Indian Journal of Pharmaceutical Sciences*.46.4.148-149.

16. Saraswatiibhai N (1954). Chemical investigations of the stem bark of H. isora; *Buletin of Central Research Institute University Tranvancore Trivendrum,* Sec A-3.89-103

17. Barik B. R., Dey A.K. and Das P.C. (1982).H. isora Linn- a new source of diosgenin *Indian Journal of Chemistry*.4.1.8204-0237.

18. Nair S, Grampurohit N.D. (1996).*Studies on an Ayurvedic drug Helicteres isora Linn [M]. India: SNDT Women's University*.

19. Ogbole O.O, Ekor M.N, Oluremi B.B, Ajaiyeoba A.A, Gbolade A.A, Ayoola A.M and Adeyemi A.A. (2007) Anti-inflammatory and antimicrobial activities of Hippocratea indica root bark and Pogaoleosa fruits. *African Journal of Traditional Complementary and Alternative Medicines*; 4.3.372-376.

20. Kusumoto I.T, Shimada I, Kakiuchi N, Hattori M, Namba T, Supriyatna S. (1992).Inhibitory effects of Indonesian plant extracts on Reverse Transcriptase of an RNA Tumour Virus (I) *Phytother Res*.6.241–4.

21. Gayatri P, Gayatri Devi S. Shigami Srinivasan, Saroja S. (2010) Screening and Quanitation of Phytochemicals and Nutritional Componenet of fruits and Bark of Helecteres Isora *Hygenia. J. D. MED.* 2.1.57-62.

22. Chakrabarti R, Vikramadithyan R.K, Mullangi R, Sharma V.M, Jagadheshan H, Rao Y.N (2002)Antidiabetic and hypolipidemic activity of Helicteres isora in animal models. J Ethnopharmacol; 81.3.343-349.

23. Kumar G, Murugesan A.G. Influence of Helicteres isora bark extracts on plasma and tissue glycoprotein components in streptozotocin diabetic rats. Journal of Clinical and Diagnostic Research 2007; 4:330-8.

24. Tambekar D.H, Khante B.S, Panzade B.K, Dahikar S.B, Banginwar Y.S. (2008).Evaluation of phytochemical and antibacterial potential of Helicteres isora L. fruits against enteric bacterial pathogens. *Afr J Tradit Complement Altern Med*. 5.3.290-3.

25. Basniwal P.K, Suthar M, Rathore G.S, Gupta R, Kumar V, Pareek A, (2009) In vitro antioxidant activity of hot aqueous extract of Helicteres isora Linn. Fruits. *Natural Product Radiance*.8.5.483-7.

26. Loganayaki N, Siddhuraju P, Manian S. (2013) Antioxidant activity and free radical scavenging capacity of phenolic extracts from Helicteres isora L. and Ceibapentandra L. *J Food Sci Technol*. 50.4.687-695.

27. Venkatesh S, Sailaxmi K, Reddy B.M, Ramesh M. (2007) Antimicrobial activity of Helicteres isora root. Indian Journal of Pharmaceutical Sciences. 69.687-9.

28. Shriram V, Jahagirdar S, Latha C, Kumar V, Dhakephalkar P, Rojatkar S. (2010)Antibacterial & antiplasmid activities of Helicteres isora L. *Indian J Med Res*.132.94-99.

29. Bhoopati R. A, Elanchezhiyan C, Sethupathy S.(2010)Antihyperlipidemic activity of Helicteres isora fruit extract on streptozotocin induced diabetic male Wistar rats. *Eur Rev Med Pharmacol Sci*.14.191-6.

30. Venkatesh S, Reddy BM, Reddy G.D, Mullangi R, Lakshman M. (2010) Antihyperglycemic and hypolipidemic effects of Helicteres isora roots in alloxan-induced diabetic rats: a possible mechanism of action. J Nat Med. 64.3.295-304.

31. Kumar V, Sharma M, Lemos M, Shriram V. (2013) Efficacy of Helicteres isora L. against free radicals, lipid peroxidation, protein oxidation and DNA damage. *Journal of Pharmacy Research*. 6.6.620-5.

32. Chitra M.S, Prema S. (2009) Hepatoprotective activity of Helicteres isora Linn. Against CCl4 induced hepatic damage in rats. Hamdard Medicus. 52.1.112-5.

33. Pradhan M, Sribhuwaneswari S, Karthikeyan D, Minz S, Sure P, Chandu AN et al. (2008) In vitro cytoprotection activity of Foeniculum vulgare and Helicteres isora in cultured human blood lymphocytes and antitumour activity against B16F10 melanoma cell line. Research Journal of Pharmacy and Technology. 1.4.450-2.

34. Raaman N, Balasubramanian K, et al. (2012) Antioxidant and anticancer activity of Helicteres isora dried fruit solvent extracts. *J Acad Indus Res*; 1.3.148-52.

35. Chakrabarti R. Reeba K, Vikramadithyan R.M., Sharma V.M., Jagdheshan. N. Rao Y.N, Sairam P. Rajgopalan R, (2002) Antidiabetic and Hypolipidemic Activity of Helicteres isora in animal models, of Ethanopharmacology. 81.343-349.

36. Kumar G. and Murgesan A.G. (2008).Hypolipidaemic effect of extracts of Helicteres isora L bark extracts in streptozotocin induced diabetic rats, *Journal of Pharmacology* 116.161-166.

37. Bhavsar S.K, Föller M, Gu S, Vir S, Shah M.B, Bhutani K.K et al. (2009)Involvement of the PI3K/AKT pathway in the hypoglycemic effects of saponins from Helicteres isora. J Ethnopharmacol. 126.3.386-396.

38. Dhevi R., Gayathri K, Shabi M.M, Subashini U, Dubey G.P, Rajamanickam G.V et al. 2008 A preliminary biochemical screening of Helicteres isora L. stem bark in carbon tetrachloride induced toxicity in rats. Bulgarian Journal of Veterinary Medicine. 11.4.235-242.

39. Sable P., Grampurohit N., Banarjee S., Gaikwad D., Gadhave M. (2012) Recent Advances on The Phytochemicals and Pharmacological profile of plant Helicteres Isora Linn. *International Research Journal of Pharmacy*.3.4.14-17.

40. Kumar T.M, Christy A.M, Ramya R.C, Malaisamy M, Sivaraj C, Arjun P, et al. (2012) Antioxidant and anticancer activity of Helicteres isora dried fruit solvent extracts. *J Acad Indus Res.*1.3.148-152.

41. Basniwal P.K, Suthar M, Rathore G.S, Gupta R, Kumar V, Pareek A, et al. (2009)In vitro antioxidant activity of hot aqueous extract of Helicteres isora Linn. Fruits. *Natural Product Radiance*; 8.5.483-7.

42. Loganayaki N, Siddhuraju P, Manian S. (2013) Antioxidant activity and free radical scavenging capacity of phenolic extracts from Helicteres isora L. and Ceibapentandra L. *J Food Sci Technol*; 50.4.687-95.

43. Bhat B.A, Elachezhiyan C, Sethupathy S. (2012) In vitro antioxidative role of Helicteres isora. International Journal of Bioassays.1.12.177-83].

44. Kumar G, Banu G.S, Murugesan A.G, Pandian M.R. (2007) Effect of Helicteres isora bark extracts on brain antioxidant status and lipid peroxidation in streptozotocin diabetic rats. *Pharm Biol*.45.10.753-759.

45. Varghese E, Narayanan S.S, Gopal RV, Nair A, Chittethu A.B, Anson T.A. (2011) Anticancer activity of chloroform extract of Helicteres isora. *Int J Pharm Technol*; 3.2. 2560-2564.

46. Venkatesh S., Sailaxmi K., Madhara B., Reddy, Ramesh M., (2007) Antinociceptive Activity of Helicteres isora, *Fitoterpia* 78.146-147.

47. Dama G.Y., Tare H.L., Gore M.S., Shende V.S. Deore, Khandagale S.T., Kandeker A,E., (2011)comparative cardiotonic activity of Helicteres isora with Digoxin on isolated frog Heart International Journal of Preclinical Research .2 .2.81-86.

48. Kumar G. Murugesan A. (2008).Hypolipidemic activity of Helicteres isora L. Bark extracts in streptozocin induced Diabetic rats, *Journal of Pharmacology*.116.161-166.

49. Chopra R.N, Nayar S.L, Chopra I.C. Glossary of Indian medicinal Plants. Reprint. New Delhi: Publication and Information Directorate, CSIR (2012)63-69.

50. Tambekar D.H, Khante B.S, Panzade B.K, Dahikar S.B, Banginwar Y.S.(2008)Evaluation of phytochemical and antibacterial potential of Helicteres isora L. fruits against enteric bacterial pathogens. *Afr J Tradit Complement Altern Med*.5.3.290-3.

51. Shriram V, Jahagirdar S, Latha C, Kumar V, Dhakephalkar P, Rojatkar S, et al. (2010).Antibacterial &antiplasmid activities of Helicteres isora L. *Indian J Med Res*. 132:94-9.

52. Asolkar L.V, Kakkar K.K, Chakre O.J. Second supplement to glossary of Indian medicinal plants with active principles. Reprint. New Delhi: Publication and Information Directorate, CSIR (2012).7883.