Review Article

PHARMACOGNOSTIC PROFILE AND PHARMACOLOGICAL ACTIONS OF *Helicteres isora* Linn: A REVIEW

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ABSTRACT:

The single use of herbal medicines, or in combination with other therapies are a prominent choice of many people as they can demonstrate advantages over chemotherapy or radiotherapy such as the reduction of side effects and efficiency for long term use. The development of many current medicines for the treatment of various diseases such as inflammation, diabetes, or cancer is primarily based on natural sources, including herbal plants. *Helicteres isora* Linn has been used traditionally as a folk medicine for treatment of various common diseases such as colic, constipation, diabetes, gastropathy, scabies, diarrhea, dysentery, snake bite, dog bite and inflammation. As a potential medicinal plant, many attempts have been made to identify the key bioactive compounds in *H. isora* and conduct in-vitro and in-vivo tests to investigate their potential as therapeutic agents for various diseases. 80% of world's population relies on traditional medicines and plant extracts and the active constituents are used to meets people's primary healthcare needs. This review focuses on compilation of pharmacognostic profile and pharmacological actions of *Helicteres isora* Linn plant.

Key wards: Ayurveda, *Helicteres isora*, Pharmacological actions, Phytoconstituents.

INTRODUCTION:

Helicteres isora Linn. (*H. isora*) is a large genus of tropical trees and shrubs belongs to family Sterculiaceae, with axillary flowers and fruits consisting of five twisted carpels. The origin of *H. isora is* new Latin, from Greek *heliktēres*, plural of *heliktēr* anything twisted, from *helik-*, *helix* spiral [1]. *H. isora* is a shrub or small tree belongs to family Sterculiaceae. It spreads rapidly with stem measuring 1-5 inches in diameter, reaching a height of 5-15 feet. This species is native to Asia and Australia [2]. It is commonly known as Marodphali, Marorphali, Enthani, etc. due to the screw-like appearance of its fruit. It is not described broadly in the ancient text of Ayurveda, namely Samhitas and Nighanthu. This plant can come from outside so it is neglected by Ayurvedic authors. In the description from the Ayurvedic plant Murva, Avartphala is also confusing with Murva, but later confirmed with a separate plant instead of Murva. Avartphala leaf resembles Parushaka (Grewia Asian Linn) [3].

Pharmacognostic profile of *Helicteres isora* Linn.

Botanical name: *Helicteres isora* Linn.

Scientific Synonyms [4]: The various scientific synonyms of *H. isora* are enlisted in Table 1.

Table 1: Scientific synonyms of *H. isora*

Sr. No.	Scientific synonyms
1	Helicteres chrysocalyx Miq. ex Mast.
2	Helicteres corylifolia Buch.-Ham. ex Dillwyn
3	Helicteres grewiaefolia DC.
4	Helicteres isora var. glabrescens Mast.
5	Helicteres isora var. microphylla Hassk.
6	Helicteres isora var. tomentosa Mast.
7	Helicteres macrophylla Wight ex Wight & Arnold
8	Helicteres ovata var. fructus-regis Lam.
9	Helicteres ovata var. isora-murri Lam.
10	Helicteres roxburghii G. Don
11	Helicteres versicolor Hassk.
12	Isora corylifolia Schott & Endl.
13	Isora grewiaefolia (DC.) Schott & Endl.
14	Isora versicolor Hassk.
15	Ixora versicolor Hassk.

Common names

It is commonly known as Indian screw tree, East Indian screw tree, Deer's horn in English, Avartani, Avartaphala in Sanskrit, Marodphali, Marorphali, Enthani, Gomathi in Hindi, Kewad, Muradsheng in Marathi, Antamora in Bengali, Maradashingh in Gujrati, Yedmuri in Kannada, Valampuri in Telgu, Idampiri valampiri in Malayalam, S̄amunpra pai ka bid in Thai, Liniya in Sinhala, Muemuriya in Oriya, etc [3, 5].

Other vernacular names include mochra, mudmudika, kurkurbicha, sinkri, valumbari, yedamuri, pita baranda, balampari, guvadarra, pedamuri, ishwarmuri, murmuriya, and vurkatee. In Indonesia it is called buah kayu ules or ulet-ulet on Java [5, 6].

The scientific classification of *H. isora* is shown in Table 2

Kingdom	**Plantae**
Clade	Tracheophytes
Clade	Angiosperms
Clade	Eudicots
Clade	Rosids
Order	Malvales
Family	Malvaceae
Genus	Helicteres
Species	*H. isora*

Geographical Distribution

H. isora is a tropical Asian plant. It is found throughout India and Pakistan, Nepal, Myanmar, Thailand and Sri Lanka. It is also found on the Malay Peninsula, Java, and Australia [6]. In India it is found in dry forests throughout Central and Western India, from Bihar as far West as Jammu and Western Peninsula [3].

Plant Description:

H. isora is a small tree or shrub, from 5 to 8 meters tall. It has gray bark and leaves arranged alternately, hairy, ovate, with serrated edges. Its flowers are reddish-brown or orange-red, and its fruits are green when raw, brown, or gray when dry and twisted, with a screw at the sharp end. The seeds of the plant are black or brown and are very polished, roughly rhomboid and rectangular or triangular [7]. Flower pollinators include the jungle stammer, the golden-leafed bird, the gray drongo and the white-bellied drongo [8]. Fruits, seeds, roots and bark of the plant are used. The flowering time of *H. isora* is from the month of April to December, and the fruiting time is from the month of October to June [9]. Different parts of the *H. isora* plant are shown in Fig. 1.

Figure 1: Different parts of *H. isora* Linn. (A: Plant, B: Flower, C: Immature pod, D: Stem bark and E: Mature pod)

Phytoconstituents

The plant roots contain cucurbitacin B and isocucurbitacin B which are reported to possess cytotoxic activity [5]. Harde PA and Shah MB have determined the oleanolic acid from the roots of *Helicteres isora* Linn by HPLC method [6]. The fruits contain neolignans, helisterculins A and B and helisorin and posses weak inhibitory action against reverse transcriptase from avian myeloblastosis virus [7]. Recently, three major compounds of *H. isora* have been identified which were 4'-*O*- β - D-glucopyranosyl rosmarinic acid, 4,4'-O-di- β-D-glucopyranosyl rosmarinic acid, and 2R-O-(4'-O-β-D-glucopyranosyl caffeoyl)-3- (4-hydroxyphenyl) lactic acid [8]. The leaves contain tetratriacontanyl-tetra-tricontanote, flavones-5, 8-dihydroxy-7,4'-dimethoxyflavone, trifolin and hibifolin [9,10]. It is manifest that the plant has great potentials in treating various diseases. Leaves of this plant contain tannins which are reported to possess anthelmintic activity [11]. The preliminary phytochemical screening of the fruit and bark of *Helicteres isora* contained the presence of polyphenols, tannins, carotenoids, flavonoid, carbohydrates, proteins, fibres, and minerals such as calcium, phosphorus and iron [12]. The fruit of *Helicteres isora* contained more amounts of polyphenols, ascorbic acid and carotenoids than the bark. The bark contained more amounts of tannins, flavonoids, α-tocopherol and reduced glutathione when compared to the fruit. Among the nutrients, the fruit contained more amounts of phosphorus and the bark contained significant quantities of total carbohydrates, calcium and iron than the fruit [12,13]. The phytochemical screening of flower *Helicteres isora* revealed that presence alkaloids, carboxylic acid, coumarins, tannins, phenol, xanthoproteins, and carbohydrates [14]. Phytochemical analysis of the methanolic extract of *Helicteres isora* fruits revealed the presence of three major constituents such as sanguinarine, berberine chloride and muscimol [15].

Table 3: Phytoconstituents of *Helicteres isora* Linn.

Sr. No.	Plant part	Phytoconstituents	Reference
1	Roots	Cucurbitacin B, Isocucurbitacin B, and Oleanolic acid	[5, 6]
2	Fruits	Neolignans, Helisterculins A, Helisterculins B, Helisorin, 4'-*O*- β - D-glucopyranosyl rosmarinic acid, 4,4'-O-di- β-D-glucopyranosyl rosmarinic acid, 2R-O-(4'-O-β-D-glucopyranosyl caffeoyl)-3- (4-hydroxyphenyl) lactic acid, Sanguinarine, Berberine chloride and Muscimol	[7, 8, 15]
3	Leaves	Tetratriacontanyl-tetra-tricontanote, Flavones-5, 8-dihydroxy-7,4'-dimethoxyflavone, Trifolin and Hibifolin	[9, 10]
4	Fruit and Bark	Polyphenols, Tannins, Carotenoids, Flavonoid, Carbohydrates, Proteins, Fibres, andnd Minerals such as Calcium, Phosphorus and Iron	[12]
5	Flowers	Alkaloids, Carboxylic acid, Coumarins, Tannins, Phenol, Xanthoproteins, and Carbohydrates	[14]

Table 4: Structures of important chemical constituents in *Helicteres isora* Linn

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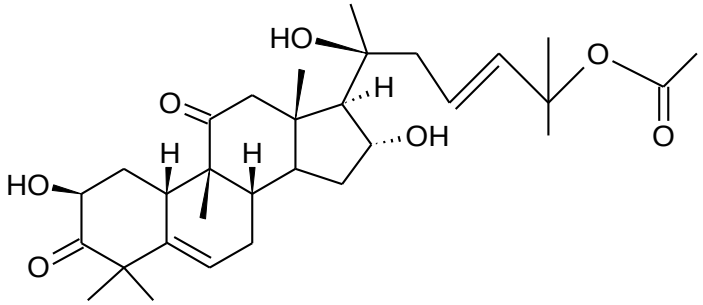
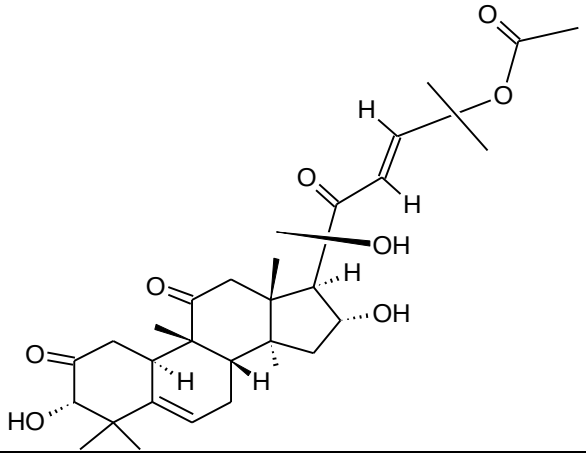
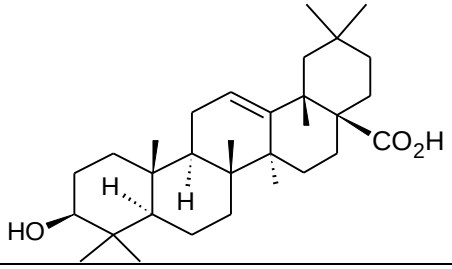
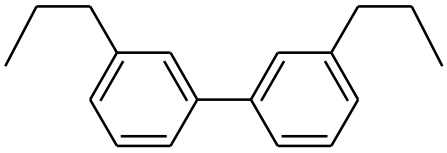
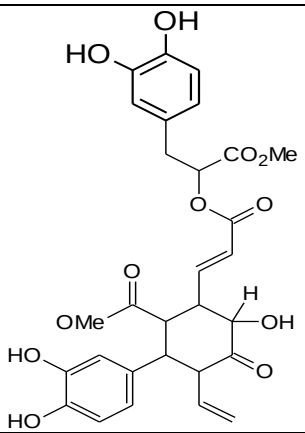
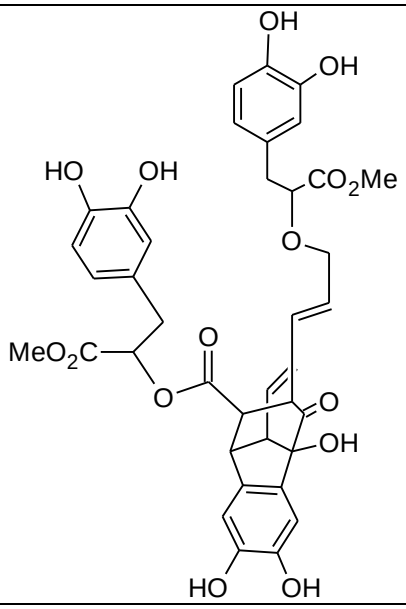
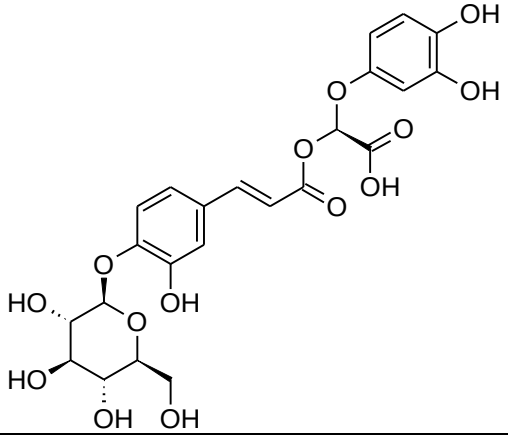
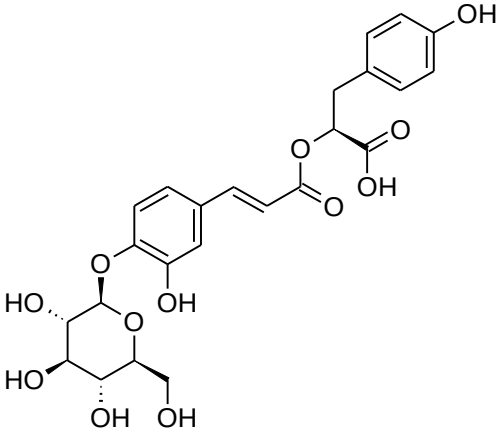
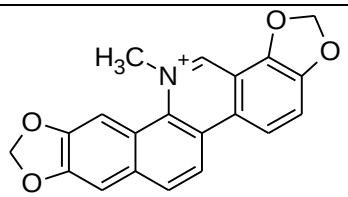
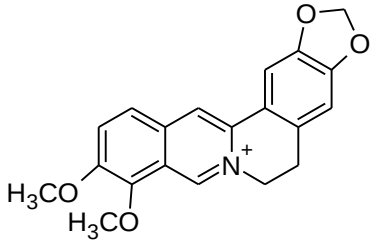
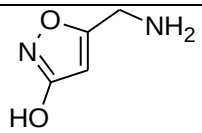
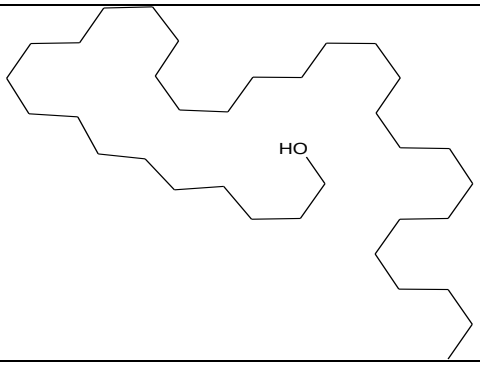
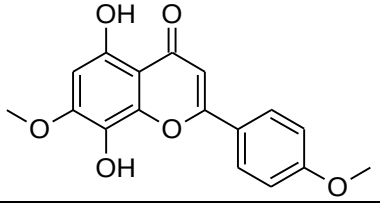
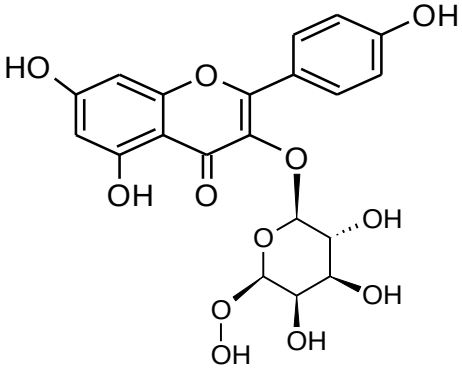
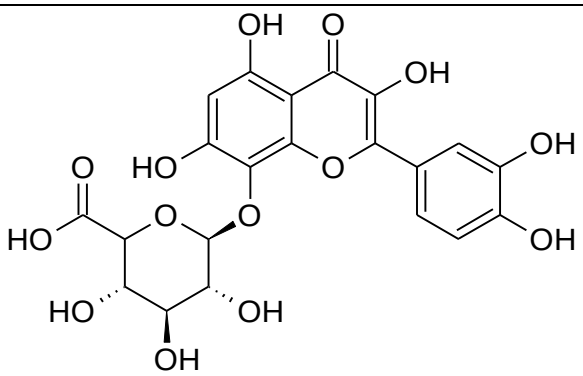
Sr. No.	Chemical Constituent	Structure
1	Cucurbitacin B	

2	Isocucurbitacin B	
3	Oleanolic acid	
4	Neolignans	
5	Helisterculins A	

6	Helisorin	
7	4'-*O*- β - D-glucopyranosyl rosmarinic acid	
8	2R-O-(4'-O-β-D-glucopyranosyl caffeoyl)-3- (4-hydroxyphenyl) lactic acid	
9	Sanguinarine	

10	Berberine	
11	Muscimol	
12	Tetratriacontanyl-tetra-tricontanote	
13	Flavones-5, 8-dihydroxy-7,4'-dimethoxyflavone	
14	Trifolin	
15	Hibifolin	

1. Antidiabetic and Hypolipidaemic Activity

Chakrabharti *et. al.,* revealed the antidiabetic and hypolipidemic activity of ethanolic extract Helicteres isora L. of roots in Swiss albino mice. Ethanollic extract of Helicteres isora L. root produced a significant decrease in plasma glucose, triglycerides and insulin at a dose of 300 mg/kg after 9 days of administration to insulin-resistant and diabetic mice. Ethanolic extract of Helicteres isora L. root has insulin-sensitizing and hypolipidemic activity and also has the potential to treat Type - II diabetes mellitus [16]. Kumar G and Murugesan AG reported that the hypolipidemic activity of aqueous bark extract of Helicteres isora L. in diabetic rats induced by streptozotocin. Administration of Helicteres isora bark extract at doses of 100 and 200 mg/kg for 21 days revealed a significant decrease in serum and tissue cholesterol, phospholipids, fatty acids, and triglycerides in streptozotocin-induced diabetic rats. Also, a significant increase in high-density lipoproteins (HDL) while lowering the level of low-density lipoproteins (LDL) and very low-density lipoproteins (VLDL). Bark extracts of *Helicteres isora* L. at a dose of 200 mg/kg have a better lipid-lowering effect than 100 mg/kg [17]. Suther *et. al.,* evaluated the antidiabetic activity of *Helicteres isora* Linn Fruits. The antidiabetic effect was studied using in vitro glucose uptake in the isolated rat hemidiaphragm model [18]. Kumar G *et. al.,* reported the hypoglycemic activity of the aqueous extract of the bark of *Helicteres isora* L. in normal, glucose-loaded and streptozotocin-induced diabetic rats. In normal rats, the aqueous extract of the bark of *Helicteres isora* L. in doses of 100 mg/kg/p.o. showed a decrease in blood glucose from 64.5 to 48.5 mg% and 67 to 47 mg% after 2 hours of oral extract and also a significant reduction in blood glucose levels in streptozotocin-induced diabetic rats of 68 to 105 mg% and 66 to 85.5 mg% after 21 days of daily oral administration of the extract. The results expressed that the aqueous extract of the bark of *Helicteres isora* L. contains a potential hypoglycemic action in diabetic rats [19]. Venkatesh *et. al.,* showed the antihyperglycemic and lipid-lowering activities of root extracts of Helicteres isora L. in alloxan-induced diabetic rats. They reported that oral administration of butanol and aqueous extracts of Helicteres isora L. at a dose of 250 mg/kg for 10 days it shows a significant reduction of blood glucose, total cholesterol, triglycerides and urea in alloxan-induced diabetic rats [20].

2. Antibacterial Activity

Gayathri Devi *et. al.,* evaluated antibacterial activity of Methanolic extract of *Helicteres isora* L. fruits and bark. The both fruits and bark extract showed significant antibacterial activity against *Bacillus subtilis, Pseudomonas aeruginosa*, *Proteus vulgaris* and moderate antibacterial activity against *Bacillus subtilis, Pseudomonas aeruginosa*, *Paratyphii A* and *Staphylococcus aureus*. The petroleum ether extract showed considerable activity against *Paratyphii B*, *Salmonella typhimurium* and *E.coli.* Benzene extracts has been found to be effective against *Paratyphii B* and *E. coli,* while the choloroform and acetone extracts has been observed to be ineffective against most of the organisms tested. Hence, methanolic extract showed more significant antibacterial activity as compared to petroleum etheter, benzene, cholorform and acetone extracts [21]. Varghese *et. al.,* performed isolation and evaluation of antimicrobial properties of isolated phytoconstituents of fruits of *Helicteres isora* Linn. Minimum inhibitory concentration (MIC) value of methanolic extract against *Pseudomonas aeruginosa* and *Staphylococcus aureuswas* has found to be 10µg/ml and 8µg/ml respectively [22]. Shriram V. *et. al.,* evaluated antibacterial and antiplasmid activity of *Helicteres isora* L. fruits [23]. Tambekar *et. al.,* revealed antibacterial activities of aqueous, acetone, ethanol and methanol extracts of fruits of *Helicteres isora*. The fruit aqueous extracts of *H. isora* showed prominent antibacterial activities against *E.coli, Staphylococcus epidermidis*, *Salmonella typhimurium* and *Proteus vulgaris*; moderate activity against *Enterobacter aerogenes, Staphylococcus aureus, Salmonella typhi* and least activity against *Pseudomonas aeruginosa.* The aqueous extract showed maximal, the ethanol and methanol extract showed moderate and acetone extracts showed least antibacterial activities [24].

3. Antioxidant Activity

Kumar TM *et. al.,* evaluated the antioxidant activity of acetone, hexane and iso-propyl alcohol extract of *Helicteres isora* Linn fruits. Acetone extract of *Helicteres isora* fruits showed strong antioxidant activity as compared to hexane and iso-propyl alcohol [25]. Manke MB *et. al.,* revealed in-vitro antioxidant activity of methanolic and petroleum ether extracts of *Helicteres isora* Linn. fruits. Antioxidant activity was determined by 2, 2-diphenyl-1-picryl hydrazyl (DPPH) and Hydrogen peroxide (H_2O_2) radicals scavenging assays. The DPPH free radical scavenging activity was obtained with the methanol extract (IC_{50} 42.95 µg/ml), while petroleum ether extract showed less free radical scavenging activity (IC50 89.81µg/ml) as compared to standard ascorbic acid (IC_{50} 23.75 µg/ml). Hydrogen peroxide decomposition activity of methanol and petroleum ether extracts were showed in a concentration dependent manner with an IC_{50} 36.61 µg/ml and 74.40 µg/ml respectively, while IC_{50} value for ascorbic acid was 9.64 µg/ml. Methanol extracts showed potent antioxidant activity than petroleum ether extracts [26]. Kumar V. *et. al.,* reported that the fruits of *Helicteres isora* have broad-spectrum antioxidant potential against free radicals and significantly ameliorated various

impairments associated with free radical formation including lipid peroxidation, protein oxidation and DNA damage. The plant extracts showed concentration-dependent free radical scavenging activities and lipid peroxidation inhibition. Amongst all four extracts, aqueous-methanol extract showed highest antioxidant potential in terms of reducing power (360 ± 5.9 gallic acid equivalent), total antioxidant activity (150 ± 5.6 gallic acid equivalent), scavenging of free radicals including DPPH (75.6%) and OH (100%) in addition maximal (97.4%) lipid peroxidation inhibition at concentration of 1000 µg/ml [27]. Free radicals are known for DNA strand breaking and damage which eventually contributes to carcinogenesis, mutagenesis and cytotoxicity [28]. Kumar G. *et. al.,* evaluated effect of *Helicteres isora* bark extracts on brain antioxidant status and lipid peroxidation in streptozotocin diabetic rats. A significant increase in the activities of plasma insulin, superoxide dismutase, catalase, glutathione peroxidase, glutathione s-transferase, and reduced glutathione were observed in the brain on treatment with 100 mg/kg b.w. and 200 mg/kg b.w. of *Helicteres isora* bark extract and tolbutamide for 5 weeks in streptozotocin diabetic rats. Both *Helicteres isora* bark extracts and standard drug showed a significant decrease in thiobarbituric acid reactive substances and hydroperoxides formation in brain, suggesting that the role of *Helicteres isora* bark extracts in protection against lipid peroxidation-induced membrane damage [29]. Basniwal *et. al.,* investigated in-vitro antioxidant activity of hot aqueous extract of *Helicteres isora* L. fruits. The hot aqueous extract of *Helicteres isora* L. fruits showed significant antioxidant activity by inhibiting nitric oxide and scavenging superoxide anion as well as hydrogen peroxide radicals when compared with different standards like L-ascorbic acid, quercetin and rutin [30]. Polani *et. al.,* evaluated the antioxidant activity of aqueous, ehanolic and methanolic extracts of *Helicteres isora* fruits. The methanolic extract of fruit showed the maximal, aqueous extract showed the moderate and ethanolic extract showed least radical scavenging activity [31]. Vennila *et. al.,* revealed the in-vitro antioxidant activity of Helicteres isora L. The antioxidant activity has found in hexane, chloroform and methanol extracts of Helicteres isora. Among these three extracts, the chloroform extract showed maximal antioxidant activity than the methanol extract and hexane extract [32]. Suthar *et. al.,* evaluated antioxidant activity of hot water extract of *Helicteres isora* showed maximum activity with IC_{50} value 25.12 ± 0.18 µg/ml for 1, 1-diphenyl, 2-picryl hydrazyl assay method, and low activity with IC_{50} value 740.64 ± 4.76 µg/ml for microsomal lipid peroxidation assay. In the β-carotene-linoleate model, the extract showed 45.63% antioxidant activity [18].

4. Antifungal and Anti-biofilm Activity

Jain *et. al.,* evaluated the antifungal activity of stem bark of *Helicteres isora* Linn. The effect of methanol and petroleum extracts of stem bark of *Helicteres isora* Linn had been investigated in five different fungus i.e. *Cryptococcus neoformans, Candida tropicalis, Trychophyton rubrum, Microsporum furfures,* and *Epidermophyton floccosum*. The methanol extracts exhibited significant antifungal activity; while the petroleum ether extracts exhibited weak antifungal activity [33]. Manke MB *et. al.,* evaluated antifungal activity of methanol and petroleum ether extracts of fruits of *Helicteres isora* Linn against planktonic and biofilm growth of *Candida albicans*. Methanol extract of *Helicteres isora* Linn showed complete prevention of planktonic growth at 2 mg/ml, while petroleum ether extract had no effect up to 4 mg/ml concentration. Decrease in biofilm formation was analyzed in presence of 1 mg/ml methanol exteact, and 2 mg/ml concentration of it prevented biofilm formation significantly ($p<0.05$). In comparison, the methanol extract of *Helicteres isora* Linn fruits showed anti-biofilm activity in *C. albicans* while petroleum ether extract exhibited negligible activity against biofilm [34].

5. Anticancer and antitumor activity

Varghese *et. al.,* evaluated the anticancer activity of chloroform extract of *Helicteres isora* L. fruits. The drug has potent action against human breast cancer and anticancer activity of drug is due to presence of alkaloids and flavonoids [35]. Kumar TM *et. al.,* reported the anticancer activity of *Helicteres isora* Linn fruits solvent extracts. Acetone extract of *Helicteres isora* fruits showed better anticancer activity against human lung cancer cells while acetone and crude protein extracts showed anticancer activity against reactive oxygen species [25]. Pradhan *et. al.,* revealed *Helicteres isora* against normal human blood lymphocytes by micronucleus assay and antitumor activity against B16F10 melanoma cell line by Trypan blue exclusion assay for cell viability. Lymphocyte culture treated with 50% methanol extract of *Helicteres isora* showed very less percentage of micronucleus i.e. 0.007% as compared to standard drug doxorubicin which showed 0.018% micronucleus and 50% methanol extract of *Helicteres isora* showed antitumor activity at the concentration 300 µl/ml [36].

6. Anti-inflammatory activity

Badgujar *et. al.,* revealed the potent anti-inflammatory activity of *Helicteres isora* L. stem bark extracts in albino rats. The methanol and petroleum ether extract of stem bark *Helicteres isora* L. has screened for anti-inflammatory activity by using carrageenan induced inflammation in albino rats. The methanol extract (100 mg/kg) showed

56.14% inhibition of rat paw oedema, while petroleum ether extract showed 36.84% inhibition. Methanol extract showed significant anti-inflammatory activity as compared to petroleum ether extract [37]. Rattanamaneerusmee *et. al.,* reported anti-inflammatory activity of *Helicteres isora* L. fruits extract. Anti-inflammatory activity of extracts was studied on the levels of nitric oxide (NO), tumor necrosis factor alpha (TNF-α), production of prostaglandin E2 (PGE- 2), and cyclooxygenas-2 (COX-2). The results revealed that hexane extract showed the strongest activity on PGE-2 production with 69.68 ± 0.017% inhibition followed by 80% ethanol extracts with 57.17 ± 0.021% inhibition compared to celecoxib, the drug acted as COX-2 inhibitor. Dichloromethane extracts possessed high inhibitory activity on COX-2 production at 106.58 ± 0.003% followed by 80% ethanol extracts with 56.58 ± 0.003% inhibition compared to celecoxib. Hexane extract of *H. isora* fruit exhibited activity against TNF-α production with 51.61 ± 0.79% inhibition at 100 µg/mL [38].

7. Antipyretic activity

Tiwari *et. al.,* evaluated antipyretic activity of alcohol and aqueous extracts of *Helicteres isora* L. roots. Antipyretic activity using yeast induced pyrexia model was performed on Wistar rats of either sex. Pyrexia was induced by subcutaneous injection of 20% w/v of brewer's yeast in distilled water. Both alcohol and aqueous extracts at a dose level of 200 and 400 mg/kg b.w. showed significant antipyretic activity within 30 min. of drug administration. [39].

8. Antispasmodic Activity

Pohocha N and Grampurohit ND revealed antispasmodic activity of the fruits of *Helicteres isora* Linn. The antispasmodic activity was determined in-vitro on guinea-pig ileum against three spasmogens acetylcholine, histamine and barium chloride. The activity was compared with standard antispasmodic agents, atropine and diphenhydramine hydrochloride. The activity was also studied in-vivo by observing the gastrointestinal motility in mice using the marker technique. The results indicated that *Helicteres isora* Linn fruits possess potent antispasmodic activity [40].

9. Cardiotonic Activity

Dama *et. al.,* performed the comparative cardiotonic activity of *Helicteres isora* Linn fruits with digoxin on isolated frog heart. The preliminary study was confirmed that *Helicteres isora* showed better cardiotonic activity as compared to digoxin because *Helicteres isora* has rapid onset of action as compared to digoxin. Further study confirmed that *Helicteres isora* has reduced toxicity than the digoxin and this was an advantage *Helicteres isora* over the digitalis [41].

10. Antinociceptive Activity

Venkatesh *et. al.,* evaluated antinociceptive activity of *Helicteres isora.* Helicteres isora roots extract have studied for antinociceptive activity on acetic acid-induced writhing test in mice, at a dose of 250 mg/kg. Petroleum ether, chloroform and aqueous ethanol extracts have showed significant antinociceptive activity. Phytochemical analysis of the active extracts indicated that their major constituents are sterol, triterpenoids (petroleum ether extract) and their glycosides (chloroform and aqueous ethanol extracts), which could be responsible for observed antinociceptive activity [42].

11. Hepatoprotective Activity

Giang *et. al.,* has evaluated **hepatoprotective activity of *Helicteres isora* ethanol extract against paracetamol-induced liver injury in mice.** Ethanol extract of *H. isora* L. (250, 500 and 1000 mg/kg b.w. per day) significantly restored the **paracetamol**-induced alterations in the biochemical activities of blood and liver tissues. The hepatoprotective effect of *H. isora* L. was also confirmed by the histopathological examination of liver tissue. Histopathological examination of liver sections in mice administered with 1000 mg/kg b.w. per day doses of the extract were perfectly protected almost similar to those of untreated mice [43]. Chitra MS and Prema S have evaluated Hepatoprotective activity of *Helicteres isora* Linn against CCl_4 induced hepatic damage in rats. The parameters have studied serum total bilirubin, total protein, alanine transaminase, aspartate transaminase as well as alkaline phosphatase activities. Ethanolic root extract showed significant protection against CCl_4 induced hepatocellular injury [44].

12. Anti-protoscolice Activity

Nabaa *et. al.,* revealed in-vitro anti-protoscolice activity of the boiled water extract of *Helicteres isora* L. fruits. The boiled water extract for the *H.isora* fruits with a concentration of 300 mg/ml revealed most reliable in eliminating the viability of protoscolices after 192 hours at a percentage of 23%, compared with the albendazole drug at a percentage of 0% after 120 hours. *H. isora* fruits boiled water extract could be used as replacement chemotherapy to treat cyst hydatide infection [45].

13. Wound Healing Activity

Renuka M. and Prakash I. reported wound healing potential of *Helicteres isora* Linn leaf extracts. Wound healing activity of petroleum ether, chloroform, acetone, ethanol and hydroalcoholic extracts of *Helicteres isora* Linn leaves were evaluated by incision and excision wound rat models. The hydroalcoholic extract showed significant ($P < 0.05$) wound healing activity [46].

14. Anthelmintic Activity

Manke MB *et. al.,* revealed in-vitro anthelmintic activity of methanolic and petroleum ether extracts

of *Helicteres isora* Linn. fruits. *In-vitro* anthelmintic activity of methanol and petroleum ether extracts of *Helicteres isora* fruits were determined by the evaluation of time for paralysis and death (min.) against Indian earthworms *Pheretima posthuma*. Various concentrations of extracts were tested in the bioassay (10, 20, and 50 mg/ml). Albendazole at concentration 20 mg/ml was included as standard reference while normal saline (0.9 % NaCl) solution as control. Methanol extracts showed potent anthelmintic activity than petroleum ether extracts [26]. Tannins, a polyphenolic compound, have been reported to exhibit anthelmintic activity as they have ability to bind free proteins in the gastro intestinal tract of host animal or glycoprotein on the cuticle of the parasite and cause death of worms [26, 47]. Manke MB *et. al.*, evaluated anthelmintic potential of *Helicteres isora* bark extract in Indian adult earthworms. Earthworms were grouped and treated with extract at concentration of 10, 20 and 50 mg/mL, albendazole of 10 mg/mL as standard and normal saline as a control. The paralysis time and death time was considered as indicator of anthelmintic activity. All the extracts showed concentration dependent activity but significant activity was observed at 50 mg/mL. The extract showed better activity at concentration of 50 mg/mL with paralysis time (12.54 min) and death time (16.55 min) when compared to standard albendazole. The study revealed that the methanolic extract of *H. isora* bark have potent anthelmintic activity against Indian adult earthworms [48].

15. 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 used for dysentery and diarrhea [49].

16. Treatment of Snakebites

Aqueous and ethanol extracts of *Helicteres isora* has evaluated for *in vitro* enzyme-inhibition activity against enzymes. *Naja naja* venom neutralization assay has evaluated by minimum indirect hemolytic dose (MIHD) assay and *in vitro* tissue damaging method. Ethanolic extract of *Helicteres isora* exhibits *Naja naja* venom enzyme-inhibition activity [50].

Table 6: Reported pharmacological actions of *Helicteres isora* Linn.

Sr. No.	Part used	Reported activity	Solvent used for extraction	Reference
1	Roots	Antidiabetic and hypolipidemic activity	Ethanol	[16]
2	Bark	Hypolipidemic activity	Aqueous	[17]
3	Fruits	Antidiabetic and antioxidant activity	Hot water	[18]
4	Bark	Hypoglycemic activity	Aqueous	[19]
5	Roots	Antihyperglycemic and lipid-lowering activity	Butanol and aqueous	[20]
6	Bark and Fruits	Antibacterial activity	Petroleum ether, benzene, cholorform and acetone	[21]
7	Fruits	Antimicrobial activity	Methanol	[22]
8	Fruits	Antibacterial and antiplasmid activity	Acetone	[23]
9	Fruits	Antibacterial activity	Aqueous, acetone, ethanol and methanol	[24]
10	Fruits	Antioxidant and anticancer activity	Acetone, hexane and iso-propyl alcohol	[25]
11	Fruits	Anthelmintic and antioxidant activity	Methanol and petroleum ether	[26]
12	Fruits	Antioxidant activity	Aqueous, aqueous methanol, methanol and acetone	[27]
13	Bark	Brain antioxidant and lipid peroxidation	Aqueous	[29]
14	Fruits	Antioxidant activity	Hot aqueous	[30]
15	Fruits	Antioxidant activity	Aqueous, ehanol and methanol	[31]
16		Antioxidant activity	Hexane, chloroform and methanol	[32]
17	Bark	Antifungal activity	Methanol and petroleum ether	[33]
18	Fruits	Antibiofilm activity	Methanol and petroleum ether	[34]
19	Fruits	Anticancer activity	Chloroform	[35]

20	Fruits	Antitumor activity	Methanol	[36]
21	Bark	Anti-inflammatory activity	Methanol and petroleum ether	[37]
22	Fruits	Anti-inflammatory activity	Hexane, dichloromethane	[38]
23	Roots	Antipyretic activity	Alcohol and aqueous	[39]
24	Fruits	Antispasmodic activity	Dichloromethane	[40]
25	Fruits	Cardiotonic activity	Distilled water	[41]
26	Roots	Antinociceptive activity	Petroleum ether, chloroform and aqueous ethanol	[42]
27	Arial parts	**Hepatoprotective activity**	Ethanol	[43]
28	Roots	Hepatoprotective activity	Ethanol	[44]
29	Fruits	Anti-protoscolice activity	Boiled water	[45]
30	Leaves	Wound healing activity	Petroleum ether, chloroform, acetone, ethanol and hydroalcoholic	[46]
31	Bark	Anthelmintic activity	Methanol	[48]
32	Bark, root and seeds	Anti-diarrheal activity	-----	[49]
33	Fruits	Snake bite	Ethanol	[50]

Conclusion

The pharmacotherapeutic efficiency of Helicteres isora Linn widely used in the indigenous system of medicine. It has been established through modern testing and evaluation such as pre-clinical and clinical studies in different diseased conditions. The plant contained the presence various important preliminary phytochemicals such as polyphenols, tannins, carotenoids, flavonoid, alkaloids, steroids, saponins, coumarins, carbohydrates, proteins, fibres and minerals and also various important chemical constituents such as Cucurbitacin B, Isocucurbitacin B, Oleanolic acid, Neolignans, Helisterculins A, Helisterculins B, Helisorin, 4'-O- β - D-glucopyranosyl rosmarinic acid, 4,4'-O-di- β-D-glucopyranosyl rosmarinic acid, 2R-O-(4'-O-β-D-glucopyranosyl caffeoyl)-3- (4-hydroxyphenyl) lactic acid, Sanguinarine, Berberine, Muscimol, Tetratriacontanyl-tetra-tricontanote, Flavones-5, 8-dihydroxy-7,4'-dimethoxyflavone, Trifolin and Hibifolin which has used as the key substances for management of multiple disorders. Further studies are needed to establish the mechanism of action of these chemical constituents and more detailed cohort studies at both laboratory and clinical levels are necessary for the development of *H. isora* containing herbal formulations or in combination with other herbs to fight multiple diseases.

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