Natural Product Radiance, Vol. 7(5), 2008, pp.466-475

Review Paper

A Review on Anthelmintic Plants

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Received 27July 2007; Accepted 30 October 2007

Abstract

Modern synthetic medicines are very effective in curing diseases but also cause a number of side effects. Crude drugs are less efficient with respect to cure of diseases but are relatively free from side effects. Parasites have been of concern to the medical field for centuries and the helminths considered causing considerable problems for human beings and animals. A large number of medicinal plants are claimed to possess anthelmintic property in traditional systems of medicine and are also utilized by ethnic groups worldwide. Following the folk claims, several medicinal plants have been scrutinized for this activity using various *in vitro* and *in vivo* methods. The present review summarizes some important pharmacological and preliminary studies on medicinal plants, products thereof and isolated principles from them, which can be investigated further to achieve lead molecules in the search of novel herbal drugs.

Keywords: Anthelmintic activity, Earthworms, Tapeworms, Hookworms, Essential oil, Medicinal Plants.

IPC code; Int. cl.[8]— A61K 36/00, A61P 33/10

Introduction

Helminthic infections are among the most common infections in human beings, affecting a large proportion of the world's population. In developing countries they pose a large threat to public health and contribute to the prevalence of anaemia, malnutrition, eosinophilia and pneumonia. Although the majority of infections due to worms are generally limited to tropical countries, they can occur to travelers, who have visited those areas and some of them can be developed in temperate climates[1]. The helminthes which infect the intestine are cestodes e.g. Tapeworms (*Taenia solium*), nematodes e.g. hookworm (*Ancylostoma duodenale*), roundworm (*Ascaris lumbricoids*) and trematodes or flukes (*Schistosoma mansoni* and *Schistosoma hematobolium)*. The diseases originated from parasitic infections causing severe morbidity include lymphatic filariasis, onchocerciasis and schistosomiasis. These infections can affect most populations in endemic areas with major economic and social consequences. Helminthes also affect millions of livestock resulting in considerable economic losses in domestic and farm yard animals. Because of limited availability and affordability of modern medicines most of the world's population depends to a greater extent on traditional medical remedies. The traditional medicines hold a great promise as source of easily available effective anthelmintic agents to the people, particularly in tropical developing countries, including India. It is in this context that the people consume several plants or plant-derived preparations to cure helminthic infections[2]. Ideally an anthelmintic agent should have broad spectrum of action, high percentage of cure with a single therapeutic dose, free from toxicity to the host and should be cost effective. None of the synthetic drug available meets this requirement. Even most common drugs like Piperazine salts have been shown to have side effects like nausea, intestinal disturbances and giddiness[3]. Resistance of the parasites to existing drugs[4] and their high cost warrants the search for newer anthelmintic molecules. The origin of many effective drugs is found in the traditional medicine practices and in view of this several researchers have undertaken studies to evaluate folklore medicinal plants for their proclaimed anthelmintic efficacy[5].

Most of the screenings reported are *in vitro* studies using some worm samples like Indian earthworm *Pheretima posthuma*, *Ascardia galli*, *Ascaris lumbricoids*, etc. Adult Indian earthworm, *Pheretima posthuma* has been used as test worm in most of the anthelmintic screenings, as it shows anatomical and physiological resemblance with the intestinal roundworm parasite of human beings[6-9]. Because of easy availability, earthworms and A*scardia galli* worms are used as suitable models for screening of anthelmintic drug[10-19]. These *in vitro* screenings are important as they give basis for further *in vivo* studies.

In the present review, various screening procedure and attempts made

Piliostigma thonningii

Butea monosperma

Cucurbita maxima

Trachyspermum ammi

Punica granatum

Capparis decidua

Capparis spinosa

Anacardium occidentale

Mimusops elengi bark

Cleome icosandra

by the researchers to evaluate the efficacy of plant species to discover new possible anthelmintic molecule(s) and to establish their possible mechanism (s) of action have been discussed.

***Ocimum sanctum* Linn.**
(Family-Lamiaceae)

Commonly known as Sacred Basil (*Tulsi*) contains volatile oil of which the chief constituents are Eugenol (about 51 %), β-caryophyllene (37%) and number of sesquiterpenes and monoterpenes[20]. The essential oil and Eugenol showed potent *in vitro* anthelmintic activity against *Caenorhabditis elegans* (Nematode). During experiment various concentrations of essential oil and Eugenol were tested using Levamisole as reference standard. Both exhibited ED_{50} of 237.9 and 62.1 µg/ml, respectively. Eugenol has been suggested as the putative anthelmintic principle[21].

***Piliostigma thonningii* (Schum.) Milne-Redh.** (Family-Caesalpiniaceae)

Stem bark of this plant is used in traditional practices to treat dysentery,

snake-bite, toothache and as an anthelmintic[22]. Following the traditional claim, ethanol extract of the plant was screened for anthelmintic activity which exhibited a potent dose dependant activity against *Ascardia galli* infected cockrels by stimulating the neuromuscular junction principally and the ganglion to a lesser degree[23]. In another study, an active principle D-3-*O*-Methylchiroinositol was isolated by bioassay-guided chromatographic separation technique from methanolic extract of stem bark of the plant and screened for anthelmintic activity by larval paralysis using Levamisole as a reference drug. Third stage larvae of *Haemonchus contortus* from faecal samples of infected lambs were used in the study. D-3-*O*-Methylchiroinositol induced approximately 60% larval paralysis within 24h at 4.4 mg/ml concentration[24].

***Melia azedarach* Linn.**
(Family-Meliaceae)

A native tree of Persia, India and China, this plant has long been recognized as an insecticidal and medicinal plant all over the world. The ethanolic extract of drupes was tested for its anthelmintic activity against the tapeworm *Taenia solium* (Cestoda) and the earthworm *Pheretima posthuma* (Annelida) using Piperazine phosphate as the standard drug. The extract was found active against both the tapeworm and the earthworm tested. Also the activity was better against tapeworm *Taenia solium*, than that of Piperazine phosphate[13].

***Punica granatum* Linn.**
(Family-Punicaceae)

Locally known as Anar, is cultivated in all parts of India. The root and stem bark of the plant is used as astringent and anthelmintic in the indigenous system of medicine. The alcoholic extract of its stem bark was evaluated for its proclaimed anthelmintic potential. The activity was found dose dependant, inhibiting transformation of eggs to filariform larvae of *Haemonchus contortus*[25]. In clinical studies, the plant showed efficacy against nematodiasis in calves[26]. The stem bark is reported to contain an alkaloid, Pelletierine.

***Moghania vestita* Kuntze** syn.
Flemingia vestita Benth.
(Family-Fabaceae)

A leguminous root crop commonly found in the North eastern regions of India. Its fleshy tuberous roots along with the peel are consumed raw by the tribal people of India to cure intestinal helminth infections. In a preliminary study the crude extract of the whole root tubers of this plant was reported to be effective against *Ascaris suum, in vitro*[27]. Tegumental alterations and deformity were also observed in digenean flukes treated with the crude peel extract of the roots[28]. Further in one study, root-tuber extract (50 mg/ml) and genistein (0.5 mg/ml), an active principle isolated from the root-tuber peel were tested against live parasites (Nematode: *Ascaris suum* from pigs, *A. lumbricoids* from humans, *Ascardia galli* and *Heterakis gallinarum* from domestic fowl; Cestode: *Raillietina echinobothrida* from domestic fowl; Trematode: *Paramphistomum spp.* from cattle). The crude extract and genistein revealed complete immobilization of the trematode and cestode but not against cuticle-covered nematodes. The treated parasites also showed structural alteration in their tegumental architecture. The activity of the peel extract and genistein is attributed to the changes induced in the tegumental integrity of the parasite[18].

***Mimusops elengi* Linn.**
(Family-Sapotaceae)

In indigenous system of medicine the bark of ***M. elengi* Linn.** is reported to possess various therapeutic properties as cardiotonic, stomachic, alexipharmic, anthelmintic and astringent[29]. Various active principles such as taraxerol, taraxerone, ursolic acid, betulinic acid, α-spinosterol, β-sitosterol, alkaloid isoretronecyl tiglate and mixture of triterpenoid saponins have been reported from its stem bark. Crude alcoholic extract and its various fractions were evaluated for their anthelmintic potential using *Pheretima posthuma* (Annelida) and *Ascardia galli* (Nematode) as test worms. The crude alcoholic extract and its ethyl acetate and n-butanol fractions significantly demonstrated paralysis and also caused death of worms especially at higher concentration of 100 mg/ml as compared to standard reference Piperazine citrate (10mg/ml). The activity was attributed to the presence of polyphenolic compounds and tannins in the stem bark[19]. Tannins are believed to interfere with energy generation in helminth parasites by uncoupling oxidative phosphorylation and could bind to glycoprotein on the cuticle of the parasite, thereby may cause death[30].

***Calotropis procera* (Ait.) R. Br.**
(Family-Asclepiadaceae)

In traditional system of medicine

it is recommended for treatment of rheumatism, lupus, eczema, asthma, leprosy and syphilis[31]. The latex has been shown to possess anthelmintic activity against *Haemonchus contortus* infection in Najdi sheep in which it decreased the egg production and the number of worms in the abomasum and showed *in vitro* larvicidal activity[32]. Both fresh and aqueous extracts of dried latex of the plant were evaluated for their anthelmintic potential using earthworms as test worms. Both the extracts exhibited a dose-dependant inhibition of spontaneous motility and evoked responses to pin-prick. With higher doses (100 mg/ml of aqueous extract and 100 % fresh latex) the effects were comparable with that of 3% Piperazine. The study suggested that it might be effective against parasitic infections of both animals and humans caused by *Ostertagia, Nematodirus, Dictyocaulis, Taenia, Ascaris* and *Fasciola*[14]. The flowers of the plant were also evaluated for anthelmintic activity in comparison with levamisole through *in vitro* and *in vivo* studies and found to possess good activity against nematodes[33].

***Neolamarckia cadamba* (Roxb.) Bosser** (Family-Rubiaceae)

An ornamental plant traditionally used in stomatitis, eye inflammation and as an anthelmintic. It is reported to contain triterpenoids, alkaloids and saponins[34]. Aqueous and ethanolic extracts of mature stem-bark of the plant were screened for anthelmintic potential against earthworms, tapeworms and roundworms using Albendazole as reference drug. The ethanolic extract was found potent than aqueous extract and activity was comparable with the standard drug used in the study[35].

***Capparis decidua* Edgew.** (Family-Capparidaceae)

It is a struggling, glabrous shrub distributed throughout greater parts of India. In traditional system of medicine root bark is documented to be useful in asthma, cough, rheumatism, gout and helminthes infections. The anthelmintic activity of ethanolic extract of root bark of ***C. decidua* Edgew.** was evaluated against adult Indian earthworm *Pheretima posthuma* (Annelida) because of its anatomical and physiological similarity with roundworm parasite. The activity was found dose dependant, comparable with Piperazine citrate (10 mg/ml) at the higher concentration of 100 mg/ml of the extract used in the study[36]. The root bark is reported to contain spermidine alkaloids[37]. In another study ethanolic extract of root bark of ***C. spinosa* Linn.** was evaluated for its anthelmintic potential and has shown good anthelmintic activity against earthworm *Pheretima posthuma.* The activity was found dose dependant[15].

***Xylopia aethiopica* A. Rich.** (Family-Annonaceae)

The seeds of this plant are used commonly in Nigeria by traditional herbalists to control gastrointestinal helminth parasites. To verify the claim, anthelmintic effect of the crude methanol extract of seeds was evaluated in rats experimentally infected with the rat hookworm *Nippostrongylus brasiliensis.* The plant exhibited activity at doses between 1.2 and 2.0g/kg as measured by reduction in worm counts at necropsy[38]. Tannins, flavonoids or terpenoids present in the crude extract of ***X. aethiopica* A. Rich.** were claimed to be responsible for its activity[39].

***Butea monosperma* (Lam.) Kuntze** syn. *B. frondosa* Koenig ex Roxb. (Family-Fabaceae)

The seeds are known to possess anthelmintic activity and their efficacy has been reported against ascarids[40], stomach worms of the sheep[41], *Ascardia galli*[42]. In one study, isolated constituent palasonin, a lactone (C_{16} $H_{22}O_6$) from seeds was experimentally evaluated and found to possess significant anthelmintic property[43]. Palasonin was also screened and found to be effective against *Ascaris lumbricoids*[44] and *Fasciola hepatica*[45]. In another study, the biochemical mechanism of anthelmintic action of palasonin has been investigated on *Ascardia galli*. Palasonin inhibited the glucose uptake and depleted the glycogen content in the presence of glucose indicating that palasonin affects the energy generating mechanism of the parasite. It also significantly increased lactic acid suggesting inhibition of ATP production. The results indicated that palasonin may act via either inhibition of energy metabolism and/ or alteration in the motor activity of the parasite[46].

***Gynandropsis gynandra* (Linn.) Briq.** (Family-Capparidaceae)

Methanol extracts of leaves and stems of ***G. gynandra* (Linn.) Briq.** were investigated for their anthelmintic activity using *Fasciola gigantica* (liverfluke), *Taenia solium* (Tapeworm) and *Pheretima posthuma* (Earthworm) as test worms. Both the extracts exhibited

considerable activity in dose dependant manner and the order of sensitivity of the extracts to the worms were *P. posthuma*>*F. gigantica*>*T. solium*. The methanol extract of stem was found to be more active and showed significant activity compared to Piperazine citrate, standard reference drug used in the study[47].

***Evolvulus alsinoides* Linn.**
(Family-Convolvulaceae)

It is widely used in Ayurveda as powerful brain stimulant, aphrodisiac and anthelmintic. Ethanolic extract of the whole plant material was screened to validate its anthelmintic activity using adult Indian earthworm, *Pheretima posthuma* as model animal. The extract caused paralysis followed by death of the worms at all tested dose levels. At higher concentration of 100mg/ml the ethanolic extract was found to be more potent than the reference control Piperazine citrate[12].

***Centratherum anthelminticum* Kuntze** syn. *Vernonia anthelmintica* Willd. (Family-Asteraceae)

Commonly known as *Kalijiri* is reputed in Ayurvedic system of medicine as anthelmintic. Various extracts of seeds have been evaluated for their proclaimed anthelmintic activity by *in vivo* and *in vitro* methods. The study was conducted using *Fasciolopsis buski* and *Ascaris lumbricoides* and *Hymenolepis nana* as test worms. Alcoholic extract was found to possess maximum activity followed by ether extract while aqueous extract did not show this activity[48]. The activity was compared to levamisole. *In vitro*, studies revealed higher anthelmintic effects of methanolic extract as compared to aqueous extract on live *Haemonchus contortus* as evident from their mortality. *In vivo*, screening showed a maximum reduction (73.9%) in faecal egg counts per gram with crude aqueous extract, in sheep naturally infected with gastrointestinal nematodes[49].

***Carica papaya* Linn.**
(Family-Caricaceae)

The anthelmintic potential of the aqueous extract of Papaya was evaluated using roundworm *Ascaris lumbricoids* and *Ascardia galli* (Nematodes) as test parasites[50]. The phytoprinciple benzyl isothiocyanate was isolated from the extract as it is an active principle responsible for anthelmintic activity. The metabolic pathways in general and carbohydrate pathways in particular and neuromuscular coordination are the major target sites of action of anthelmintic compounds[51]. The compound benzyl isothiocyanate exerted its action by inhibiting energy metabolism and by affecting motor activity of the parasites, as developed by *in vitro* studies[52]. In another study, benzyl isothiocyanate isolated from ***C. papaya* Linn.** seed extract was tested for anthelmintic activity by viability assay using *Caenorhabditis elegans* and was claimed as the chief anthelmintic agent[53].

***Nigella sativa* Linn.**
(Family-Ranunculaceae)

Commonly known as *Kala Jira*, is a reputed plant in Indian system of medicine for its usefulness in a variety of ailments and possesses carminative, digestive, astringent and diuretic properties[54]. The anthelmintic potential of essential oil of ***N. sativa* Linn.** was evaluated against earthworms, tapeworms, hookworms and nodular worms and exhibited fairly good activity against earthworms and tapeworms. The activity against hookworms and nodular worms was comparable with that of hexyl resorcinol[55]. The main active principles of ***N. sativa*** are thymoquinone, dithymoquinone-cymene and α-pinene.

***Semecarpus anacardium* Linn. f.**
(Family-Anacardiaceae)

It is found throughout the hotter parts of India and its nuts are commonly known as *Bhilawa*. The various concentrations of anacardic acid, extracted from the oil of nuts and its sodium salt were tested for anthelmintic activity. Both have been found to be potent anthelmintic agent than piperazine citrate with the same concentration[56].

***Piper longum* Linn.** (Family Piperaceae)

The essential oil from the fruits of ***P. longum* Linn.** was screened for the anthelmintic activity against *Ascaris lumbricoids*. The experiment revealed that its oil has a definite paralytic action on the nerve-muscular preparation of *Ascaris lumbricoids*. The activity of oil was found to be greater than the piperazine citrate used as standard in the study[57].

***Commiphora mukul* (Hook. ex Stocks) Engl.** (Family-Burseraceae)

Guggul is one of the noted drugs in Ayurveda and Unani system. In recent times its demand in therapeutics has been substantially increased. The alcoholic extract and essential oil obtained from oleo-gum resin of ***C. mukul* (Hook. ex Stocks) Engl.** has shown good anthelmintic activity against hookworms and tapeworms. The activity was

comparable to that of reference standards piperazine phosphate and hexyl resorcinol used in the study[58].

***Trachyspermum ammi* Linn.**
(Family-Apiaceae)

The seeds,commonly known as *Ajowan*, are used as diuretic, analgesic, anthelmintic and for the treatment of asthma. In one study seed extract of the plant was screened for its anthelmintic property in sheep and it produced significant results[59]. The crude aqueous and methanolic extracts of seeds of ***T. ammi* Linn.** were also evaluated for the ovicidal efficacy by egg hatch test (EHT) on *Haemonchus contortus* ova. Lethal concentrations (LC_{50}) values were found to be 0.1698 and 0.1828 mg/ml, respectively[60].

***Ficus insipida* Willd.**
(Family-Moraceae)

The latex of some ***Ficus*** spp. including ***F. insipida* Willd.** has been traditionally used as vermifuge in Central and South America. It has been observed that anthelmintic activity is due to a proteolytic fraction called ficin and confirmed by clinical trials[61]. In another study the anthelmintic activity of the latex of this species was investigated in NIH mice (dose 4ml/kg/day), naturally infected with *Syphacia obvelata, Aspiculuris tetraptrea* and *Vampirolepis nana*. But due to high acute toxicity with haemorrhagic enteritis and weak anthelmintic efficacy, the use of latex is not recommended[62]. A study on re-evaluation of risks with the use of ***F. insipida*** latex as a traditional anthelmintic remedy has also been conducted and declared unsafe for human use[63].

***Cucurbita maxima* Duch.**
(Family-Cucurbitaceae)

Seeds of the plant are reputed in Ayurvedic system of medicine as an anthelmintic especially against tape worms. The aqueous, alcoholic and ethereal extracts of the seeds were tested *in vivo* and *in vitro* on trematodes, cestodes and nematodes. The order of decreasing potency of the extracts in the *in vitro* studies was aqueous, alcoholic and ether extract. The kymographic studies suggested that the seed extracts act by bringing about a decrease in the motility leading to temporary paralysis[64].

***Nicotiana tabacum* Linn.**
(Family-Solanaceae)

In vitro and *in vivo* anthelmintic activity of ***N. tabacum* Linn.** leaves was studied to rationalize its traditional use. Live *Haemonchus contortus* were used to assess the *in vitro* anthelmintic effect of a crude aqueous extract and methanol extract. For the *in vivo* studies both the extracts were administered in increasing doses (1.0-3.0g/kg) to sheep naturally infected with mixed species of gastrointestinal nematodes. The results of the study showed that both the extracts possess dose-dependant anthelmintic activity, justifying the use of plant in traditional system of medicine[65].

***Cleome icosandra* Linn.** syn. C. *viscosa* Linn. (Family Capparidaceae)

Commonly known as *Hul-Hul*, is an annual common weed found all over the plains of India and throughout the tropics of the world. In Ayurvedic system of medicine this plant is believed to have several medicinal properties such as stomachic, laxative, diuretic, anthelmintic and considered useful in skin diseases, itching, ulcers, leprosy, malarial fevers[66]. The crude alcohol and aqueous extracts of the seeds of ***C. viscosa* Linn.** were investigated for their anthelmintic activity against *Pheretima posthuma* and *Ascardia galli*. Various concentrations (10-100mg/ml) of each extract were tested in the bioassay, which involved determination of time of paralysis and time of death of the worms. Both the extracts exhibited considerable anthelmintic activity in dose dependant manner. The most significant activity was observed at highest concentration of 100 mg/ml against both types of worms[67].

***Cannabis sativa* Linn.**
(Family-Cannabinaceae)

The efficacy of crude extract of its leaves on the motility and morphology of *Fasciolopsis buski* was studied using scanning electron microscopy. *In vitro* treatment with 5, 10 and 20 mg/ml of crude extract in phosphate buffered saline caused paralysis of the worm followed by death and found to be more lethal than the commercial flukicide, Oxyclozanide[68].

***Trifolium repens* Linn.**
(Family-Fabaceae)

In folk medicine of the *Naga* tribes of India it is used as a deworming remedy. The anticestodal activity of ***T. repens* Linn.** was evaluated using experimental *Hymenolepis diminuta* infections in albino rats. Aerial shoot extract of the plant at the concentrations 200 and 500 mg/kg reduced the mean

fecal egg counts of *H. diminuta* by 47.72 and 54.59% and worm recovery rate by 60 and 40%, respectively. Praziquantal, the standard cestocidal drug, reduced the mean fecal egg count by 65.90% and worm recovery rate by 26.67%[Ref. 69].

***Strobilanthes discolor* T. Anders.** ((Family-Acanthaceae)

Use of its leaves in the treatment of intestinal worm infections is a common ethnobotanical practice in the *Naga* tribes of North eastern part of India. The anticestodal efficacy of leaf extract was investigated using *Hymenolepis diminuta*, rat experimental model. The effects of leaf extract were adjudged by monitoring the eggs per gram of faeces (EPG) counts and percentage worm recovery rates following treatment with methanol leaf extract of this plant to different groups of rats harbouring *H. diminuta* infections. The leaf extract showed significant reductions in EPG counts as well as in recovery of surviving worms at autopsy. A notable result of the extract's efficacy was observed against the larval stages of parasite, where no single worm was recovered at its 800 mg/kg dose administered twice daily for 3 days. Effects of plant extract on adult stages were almost comparable with that of a standard drug Praziquantel. The study suggested that the leaf extract of ***S. discolor*** possesses significant anticestodal activity and supported its use in the folk medicine[70].

***Acacia auriculaeformis* A. Cunn.** (Family-Mimosaceae)

The triterpenoid saponins isolated from funicles of this plant (Acaciaside A and Acaciaside B) were tested for *in vitro* and *in vivo* activity against *Microfilariae* and adult *Setaria cervi*. The mixture of two saponins has shown good cestocidal activity[71].

Miscellaneous studies

Some workers have reported anthelmintic activity of essential oils obtained from plants. In one study, the essential oil of ***Piper betle* Linn.** has revealed anthelmintic activity against the earthworm *Pheretima posthuma, in vitro*[72]. The anthelmintic activity of the essential oil obtained from ***P. betle*** cv. 'Sagar Bangla' was also tested against tapeworms and was found to be better than the standard piperazine phosphate and the activity against hookworm was found to be greater than the reference drug Hexyl resorcinol[73]. Seed oils of ***Gynandropsis gynandra* (Linn.) Briq.**, ***Impatiens balsamina* Linn.**, ***Celastrus paniculata* Willd.**, ***Embelia ribes* Burm. f.** and ***Mucuna prurita* Hook.** were investigated for their anthelmintic property against *Pheretima posthuma*. Three concentrations (10, 50 and 100 mg/ml) of each oil were studied for bioassay. ***Embelia ribes* Burm. f.** seed oil showed the best activity as compared to Piperazine citrate (10mg/ml) included as reference standard[74]. The essential oils of ***Anacardium occidentale* Linn.** and ***Callistemon viminalis* (Soland.) Cheel** have been found to possess anthelmintic activity against earthworms and tapeworms. The activity was found to be better than reference standard Piperazine phosphate. The oils were also found to be effective against hookworms as compared to Hexyl resorcinol[75]. The essential oil of ***Gardenia resinifera* Roth.** syn. *G. lucida* Roxb. was also evaluated and showed better efficacy against *Taenia solium* at higher concentration[76].

The *in vitro* anthelmintic activity of the aqueous and alcoholic extracts of ***Melia azedarach* Linn.** , ***Ananas comosus* (Linn.)Merr.** syn. *A. sativus* Schult. f., ***Embelia ribes* Burm. f.** and ***Mucuna prurita* Hook.** were evaluated against *Taenia canina* and *Phamphistomum cervi*. ***M. prurita*** was found more active against the trematodes[77]. Ellagitannins and complex tannins isolated from the stem bark of ***Quercus petraea* (Matt.) Liebl.** showed good anthelmintic activity[78]. In one study, different parts of ten indigenous medicinal plants were screened for their *in vitro* anthelmintic activity against *Ascardia galli* worms of birds. Preparations from ***Sapindus trifoliatus* Linn.** and ***Momordica charantia* Linn.** were found more effective than Piperazine hexahydrate[17]. The active principle, solamargine, isolated from the ripe berries of ***Solanum viarum* Dunal** was found effective against *Microfilariae* and adults of *S. cervi*[71]. In one study, the ethanolic extract of ***Centella asiatica* (Linn.) Urban** was evaluated for antifilarial activity on canine dirofilariasis (*Dirofilaria immitis*)[79].

Conclusion

Ancient classical literature and ethnomedical surveys described the use of plants in traditional system of medicines for the treatment of helminthic infections. This traditional medical wisdom is excellent proof of clinical efficacy and safety of medicinal plants. Present report is a survey of literature

indicating the screenings of crude plant extracts, essential oils and isolated active principles for *in vitro* and *in vivo* anthelmintic studies to substantiate the folk claim. To conclude, in future studies, there is need for thorough phytochemical, clinical and possible studies on molecular mechanism of action. At the same time efforts should be made to standardize the plant extracts with good anthelmintic activity and formulate best alternative herbal preparations to replace or complement the synthetic drugs which are currently in use.

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