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A review on use of medicinal plants to control parasites

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Medicinal plants have been identified and used traditionally throughout the world from the beginning of the human civilization. Several plants with various properties of healing have been mentioned earlier in the oldest Indian mythology Rig-*Veda* and *Athar-veda*, thus the history of use of medicinal plants in India dates back to 3500-1800 B.C. These medicinal plants contain active principles which are highly potent against parasites. Parasite causes a quantum of health hazard and economic losses to both human and animals. Therefore, medicinal plants are still a concern of research for their anthelmintic activity and other beneficial effects, because of increasing contraindications in the application of synthetic medicines. The use of crude medicinal plants assures health promising effect to mankind and animals due to anthelmintic efficacy without any side effects. The present review gives an introduction to some medicinal plants, method of extraction and emphasized more towards its application against specific parasites.

Keywords: Animal health, Anthelmintics, Medicinal plants, Parasites, Veterinary.

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Introduction

Anthelmintics resistance in parasites is spreading and the inefficacy of chemical anti-parasitic compounds is threatening animal health. Around the world new plants having medicinal properties against parasites of ruminants have been explored and they have shown good results. In near future, it seems likely that natural products obtained from plant extracts will become a viable alternative for control of parasites of veterinary importance. According to WHO, 80 % of the populations in the developing countries depend on traditional medicine, mostly plant drugs, for their primary health care needs[1]. Indian history of medicines dating back to 3500-1800 B.C., gives stress on the medicinal use of plants for primary health care and the *Rigveda*, which is one of the earliest document detailing medical knowledge also enlist a number of plants with different healing practices. Even today a large number of people rely on the indigenous systems of medicine, Ayurveda, Unani and Siddha. A number of plants possessing antiparasitic properties are used as potent antiparasitic agent.

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Mode of action of different phytochemicals

Saponins

Affect the permeability of the cell membrane of parasites and cause vacuolization and disintegration of teguments[2].

Benzyl isothiocyanate

Inhibit energy metabolism and affecting motor activity of the parasites[3].

Cysteine proteinases

Plant cysteine proteinases papain and chymopapain have high proteolytic activities that are known to digest nematode cuticles[4].

Isoflavones

Inhibit the enzymes of glycolysis and glycogenolysis and disturb the Ca^{2+} homeostasis and NO activity in the parasites[5].

Artemisinin

In artemisinin, biological macromolecules of the parasites are damaged by causing oxidative stress in the cells; it is done by cleavage of endoperoxide bridges by iron producing free radicals (hypervalent iron-oxo species, epoxides, aldehydes and dicarbonyl compounds)[6].

Phenolic compound

Phenolic compounds interfere the energy generation mechanism by uncoupling the oxidative phosphorylation and also interfere with the glycoprotein of the cell surface of the parasites and cause death[7].

Tannins

Tannins interfere with energy generation of worms by uncoupling oxidative phosphorylation or they binds to the free protein of the gastrointestinal tract of the host animal or glycoprotein on the cuticles of the worms and lead to death[8].

Alkaloids

Alkaloids may act on central nervous system and cause paralysis. Steroidal alkaloid and oligoglycosides are present in alkaloids which may suppress the transfer of sucrose from the stomach to the small intestine, alkaloids act as an antioxidant, capable of reducing the nitrate generation which can interfere in local homeostasis that is essential for the development of helminths[9].

Common indigenous plants having antiparasitic activity

***Carica papaya* L.,** *Papita*, Pawpaw, Papaw tree

Active principles - Papain, Benzylisothiocynate[10]

Papain, also known as papaya proteinase I, is a cysteine protease enzyme present in leaves, fruits, and seed of papaya (*C. papaya*) and mountain papaya (*Vasconcellea pubescens* A.DC. syn. *V. cundinamarcensis*). Papain consists of a single polypeptide chain with 3 disulfide bridges and a sulfhydryl group necessary for activity of the enzyme which is responsible for digestion of nematodes cuticle.

Papaya has antihelmintic activity against natural infection of *Ascaris suum* in pigs[11] and found 100 % efficacy at the dose rate of 8 g/kg b.w. The plant extracts of *C. papaya* possess a dose dependent significant effect on egg, infective larvae and adult worm of *Trichostrongulus colubriformis*[12]. The matured papaya seed has demonstrated antiamoebic activity against *Entamoeba histolytica* when used in the form of cold macerated aqueous extract[13]. The seeds also exhibit antiamoebic activity[14]. Aqueous extract of the seeds showed over 90 % efficacy against *Oesophagostomum*, *Trichuris* and *Trichostrongylus*[15]. The latex containing papain having anthelmintic properties against intestinal nematodes of poultry e.g. *Ascaridia galli* and *Capillaria* spp., showed 77.7 % reduction in eggs per gram in faeces[16]. The extract showed effective activity against larvae of *Ancylostoma caninum* in mice[17].

Butea monosperma (Lam.) Taub., *Palash*, *Dhak*, *Khakara*, *Chichra*, *Bengal kino*, Bastard teak

Active principles - Palasonin, Tannins[18]

Palasonin first isolated in 1967 is the principle constituents of *Palash* responsible for the anthelmintic activity of the seed, root, flower and leaves of *B. monosperma* syn. *B. frondosa*. Palasonin's structure, established only a year later, is strikingly similar to that of the well-known, insect-derived vesicant, cantharidin.

The different species of *Butea* has been reported to possess anthelmintic activity against *A. galli*, *Ascaris lumbricoides*, *Pheretima posthuma* (earthworm), *Toxocara canis*, *Oxyurids*, *Dipylidium caninum* and *Taenia*. The methanol extract of *B. monosperma* seeds has also shown remarkable anthelmintic activity *in vitro*[19]. An Ayurvedic herbal medicine named as Pipali Rasayana, is prepared from *Piper longum* (Pippali) and *B. monosperma* (Palash) in which ash of stem, root, flower and leaves of *B. monosperma* is used, and it has shown significant activity against Giardiasis, it produced up to 98 % recovery from the infection[20]. Borkar *et al*[21] also reported that crude extract of *B. monosperma* when used in different concentration is effective against earthworm (*P. posthuma)*, roundworm (*A. galli*) and tapeworm (*Raillietina spiralis*).

***Terminalia arjuna* (Roxb. ex DC.) Wight & Arn.**, *Arjuna tree*

Active principles - Tannin and ellagic acid[22]

Tannin is a plant polyphenolic compound that binds to proteins and various other organic compounds like amino acids and alkaloids and precipitates. It also acts as an astringent. Tannin is present in leaf, bud, seed, root and stem tissues of various species. Tannins in stem tissue are often found in the growth areas of trees, such as the secondary phloem and xylem and the layer between the cortex and epidermis. It may help regulate the growth of these tissues.

T. arjuna bark showed anthelmintic activity due to tannin both *in vitro* (eggs, larvae & adult of *Haemonchus contortus*) and *in vivo* against mixed gastrointestinal trichostrongylid nematodes of sheep[23]. Combination of *T. chebula* with 4 other plants (*Boerhavia diffusa*, *Berberis aristata*, *Tinospora*

cordifolia and *Zingiber officinale*) had a maximum cure rate of 73 % in experimental amoebic liver abscess in hamsters[24] and 89 % in experimental caecal amoebiasis in rats against *E. histolytica*. The acetone extract of *T. chebula* seeds has antiplasmodial activity against *Plasmodium falciparum*[25].

***Fumaria parviflora* Lam.,** *Papara*, *Pit papra*

Active principles - Alkaloids (Protopine, Fumarizine, Papraine, Papracine Papracinine) and Tannins[26]

Protopine is a benzylisoquinoline alkaloid occurring in *Opium poppy*, *Corydalis tubers* and other plants of the family Papaveraceae, like *Fumaria officinalis*. It inhibits histamine H1 receptors and platelet aggregation and also acts as an analgesic.

Water and ethanol extracts of *F. parviflora* possess significant anthelmintic efficacy against *Trichostrongylus, Haemonchus* and *Trichuris* infections in sheep[27]. The aqueous and ethanolic extracts of *F. parviflora* exhibited ovicidal and larvicidal effects (up to 77.6 % reduction in faecal egg count) against gastrointestinal nematodes of sheep like *H. contortus, Trichostrongylus* spp., *Ostertagia circumcincta, Strongyloides papillosus, Oesphagostomum columbianum, Chebertia ovina* and *Trichuris ovis*[28].

***Allium sativum* L.**, *Lahsun*, *Lasum*, *Lassan*

Active principle - Oxygenated sulphur compound Allicin[29]

Allicin, an organosulfur compound obtained from garlic was first isolated and studied in the laboratory by Chester J. Cavallito and John Hays Bailey in 1944. When fresh garlic is chopped or crushed, the enzyme alliinase converts alliin into allicin which is responsible for the aroma of fresh garlic. The allicin generated is very unstable and quickly changes into a series of other sulfur containing compounds such as diallyl disulfide. It exhibits antibacterial, antifungal, antiviral and antiprotozoal activity. Allicin is garlic's defense mechanism against attacks by pests.

The growth of protozoan parasites such as *Giardia lamblia, Leishmania major, Leptomonas colosoma* and *Crithidia fasciculata* has been inhibited very efficiently by allicin @30 µg/mL[30]. It has also been reported that oil of *A. sativum* possess anthelmintic activity and castoffs all injurious parasites present in the intestine[31]. *A. sativum* has shown anthelmintic action against *Heterakis gallinae, A. galli*[32], *H. contortus*[33] and eggs of *A. suum*[34] *in vitro*. *In vivo* it is also effective against *Strongyloides* in donkey[35]. Alcoholic extract of *A. sativum* produced significant reduction in frequency and amplitude of contractile activity of amphistomes *Gigantocotyle explanatum* at 1000 and 300 µg/mL concentration. Complete paralysis was observed at 3000 µg/mL after 15 min of drugs administration[36]. Alcoholic extract of *A. sativum* was also effective against adult *Cotylophorun cotylophorum* at low concentrations[37]. Oil extract of *A. sativum* caused destructive alterations and deformity in the cuticle of *H. contortus* and tegumental architecture of *Moniezia expansa*[38].

***Cucurbita máxima* Duchesne**, Pumpkin, *Kaddu*

Active principle - Cucurbitin[39]

Cucurbitin is an amino acid and a carboxypyrrolidine that is found in cucurbita seeds, causes degenerative changes in the reproductive organs of parasitic flatworms like flukes.

C. maxima has shown therapeutic efficacy against clinical cases of nematodiasis in calves[40]. Strong antimalarial activity in mice has been shown by the crude ether extract of dry *C. maxima* seeds[41]. The aqueous and ethanol extracts of *C. maxima* seeds have exhibited good anthelmintic activity against *M. expansa*, *Fasciolopsis buski*, *A. lumbricoides* and *Hymenolepis diminuta*[33]. Studies conducted in China on humans have shown that pumpkin seeds are helpful for people with acute schitosomiasis[42]. Pumpkin extract has siginificant effect on the motility of mature *H. contortus* of sheep *in vitro*[43]. High effect on pig nodular worm, *Oesophagostomum* spp. has also been shown by pumpkin seeds[44]. Crude aqueous extract of pumpkin seed is also useful against dwarf tapeworm *Hymenolepis nana* in mice[45].

***Zingiber officinale* Rosc.**, Ginger, *Adrak*, *Ada*, *Sonth*

Active principles - Zingiberene and bisabolene, gingerols and shogaols[46]

Zingiberene, a monocyclic sesquiterpene is the predominant constituent of oil of ginger (*Z. officinale*), from which it gets the name. It can contribute up to 30 % of the essential oils in ginger rhizomes and gives ginger its distinct flavoring.

The anthelmintic activity possessed by the alcoholic extracts of rhizomes of *Z. officinale* against human *A. lumbricoides* is remarkable[47]. *Z. officinale* also has molluscicidal and antischistosomal activities[48]. Khandagle *et al*[49] extracted essential oils by steam distillation from rhizome of *Z. officinale* and leaf and stem of *Achyranthes aspera* to evaluated the larvicidal, attractant/repellent and oviposition attractant/deterrent activity against two mosquito species, viz. *Aedes*

aegypti and *Culex quinquefasciatus*. They found that *Z. officinale* showed highest larvicidal activity for *A. aegypti* and *C. quinquefasciatus*. *Z. officinale* also has anticestodal activity against *H. nana*[50]. It has also shown 100 % efficacy against *H. contortus* worms within 2 h post exposure[33]. *Z. officinale* possesses larvicidal properties and was used as larvicidal agent against *Angiostrongylus cantonensis*[51]. In addition, it exhibited stronger activity against canine dirofilariasis when compared to other plant extracts used[52].

***Nigella sativa* L.**, Black cumin, *Kali jeera*, *Kolajeera*, *Kalo jeeray*

Active principles - Thimoquinone, Dithimo quinone- Cymen α-pinane[53]

Thimoquinone is a short-chain ubiquinone derivative that may potentially act as a pro-oxidant found in the plant *N. sativa* particularly in seeds. It is also found in select cultivated *Monarda fistulosa* plants which is grown and steam distilled in USA for producing essential oil.

Appreciable anthelmintic activity against earthworms, tapeworms, hookworms and nodular worm is reported in the essential oils of *N. sativa*[54]. Kailani *et al*[55] in their study evaluated antifasciolic efficacy of powdered seeds, which have antischistosomicidal properties; it is effective against all the stage of *Schistosoma mansoni* e.g. miracidia, cercariae as well as adults, showed inhibitory effect on egg lying of adult female worm and also decreased activities of antioxidant enzymes, glutathione peroxidase, glutathione reductase and superoxide dismutase and enzymes of glucose metabolism, glucose-6-phosphate dehydrogenase and hexokinase[51]. Hydroalcoholic extract of *N. sativa* was found highly effective against *E. histolytica* at 125 µg/mL concentration[56]. Extract of the dried seeds in ethyl alcohol have been used as anticestodal agents[57]. When ivermectin and *N. sativa* oil are used in combination they are reported to show greater anthelmintic activity against *H. contortus*, *M. expansa* and *Fasciola gigantica*[58].

***Piper longum* L.**, Long pepper, *Pipli*

Active principle - Piperine[59]

Piperine, along with its isomer chavicine is the alkaloid responsible for the pungency of black and long pepper. Piperine forms monoclinic needles, which is slightly soluble in water and highly soluble in alcohol, ether and chloroform. Alcoholic solution has a pepper-like taste. This alkaloid compound is mainly responsible for anthelmintic activity. Piperine is present in fruits and leaves of *P. longum.*

Complete paralysis was observed in *Gigantocotyle explanatum* at 3000 µg/mL after 15-20 min. of exposure[36]. Paralysis of *A. lumbricoides* has been reported on administration of *P. longum*[60]. Caecal amoebiasis in mice has been controlled most effectively by the extract from *P. longum* fruits at a concentration of 1000 mg/kg[61]. The leaf extract of *P. betle* has exhibited significant schizonticidal activity against malarial parasites[62]. Fruits of *P. longum* have been reported to be successful in controlling the *C. quinquefasciatus* which is a vector of filariasis[63].

***Flemingia procumbens* Roxb. syn. *F. vestita* Baker**

Active principle - Genistein[64]

Genistein is a phytoestrogen and comes under the category of isoflavones, found in a number of plants including lupin, fava beans, soybeans, kudzu and psoralea. It exerts its anthelmintic activity by inhibiting the enzymes of glycolysis and glycogenolysis and disturbing the Ca^{2+} homeostasis and NO activity in the parasites.

Genistein exhibits properties that are highly effective against intestinal parasites of poultry such as cestode *Raillietina echinobothridia*[65], pork trematode *Fasiolopsis buski*[66] and sheep liver fluke *Fasciola hepatica*[67]. Genistein and its derivatives, Rm6423 and Rm6426 are potent cestocides against *Echinococcus multilocularis* and *E. granulous* metacestodes[68].

***Melia azedarach* L.**, *Bakain, Vilayati neem, Ghoda neem*

Active principles - Mliacaprin, Scopoletin, Meliartenin[69]

Mliacaprin, Scopoletin and Meliartenin are the main active constituents of *M. azedarach*. These are limonoids phytochemicals found abundant in citrus fruit and other plants of the families Rutaceae and Meliaceae.

M. azedarach extracts have larvicidal and ovicidal activity on *H. contortus*[70]. Ethanolic extract has better anthelmintic activity against *T. solium* than that of piperazine phosphate[71]. *M. azedarach* extract was viable in reducing the viability of *Trichmonas vaginalis*[72]. Extracts have been found effective against the tick *Boophilus microplus*, the malarial vector *Anopheles stephensi*, *C. quinquefasciatus* and the dengue vector *A. aegypti* and the human lice *Pediculus humanus capitis*[73]. Larval development of *H. contortus* was completely (100 %) inhibited by the

aqueous and hydro-alcoholic extracts of *M. azedarach* leaves and seeds at 12.5 mg/mL concentarion[74].

***Ocimum sanctum* L.**, Sacred basil, *Tulsi*

Active principles - Eugenol, β-caryophyllene, Urosilic acid[75]

Eugenol is a phenylpropene, an allyl chain-substituted guaiacol which is a member of the phenylpropanoids compounds. It is a colorless to pale yellow oily liquid extracted from certain essential oils especially from clove oil, nutmeg, cinnamon, basil and bay leaf.

Singh and Nagaichi[76] evaluated the antiparasitic effects of ethyl alchohol extract of *O. sanctum* against *A. galli in vitro.* Various essential oils and eugenol isolated have shown potent anthelmintic activity against *Caenorhabditis elegans*[77]. Leaf extract of *O. sanctum* showed potent antiplasmodial activity against *Plasmodium falciparum*[78]. Oil of *O. sanctum* showed larvicidal efficacy against larvae of *A. stephensi*, *A. aegypti* and *C. quinquefasciatus*[79]. Leaf and flower extract has also showed larvicidal property against larvae of *A. aegypti* and *C. quinquefasciatus*. Leaf extracts were found to be more effective against both types of mosquitoes then flower extracts[80]. Aqueous extract of leaves is also effective against *Cotylophoron cotylophorum*[81].

***Azadirachta indica* A. Juss.**, *Neem*

Active principle - Azadirachtin[82]

Azadirachtin, compound belonging to the limonoid group, is a secondary metabolite present in neem seeds. It is a highly oxidized tetranortriterpenoid which boasts a plethora of oxygen bearing functional groups, including enol ether, acetal, hemiacetal, tetra-substituted epoxide and a variety of carboxylic esters.

A. indica alcoholic extract was found effective against *F. gigantica*[83]. Aqueous and alcoholic extracts of flowers showed anthelmintic activity against *Setaria cervi*[84]. Aqueous and Methanolic extract of leaves is effective against *H. contortus*[33]. Aqueous extract exhibited anthelmintic activity in dose-dependent manner showing maximum efficacy at 40 mg/mL against *A. galli* and *Raillietina* species[85]. Ethanolic bark extract showed most significant anthelmintic activity as compared to the aqueous extracts against *A. galli*[86]. *A. indica* possesses larvicidal activity against *C. felis* and *Xenopsylla brasiliensis*[87]. The seed showed very high level of efficacy (80 %) after 5 h of treatment against *B. microplus*[88]. Aqueous and methanol extract of seed reduced faecal egg count and larval counts from co-procultures against *H. contortus and Trichostrongylus* species[89]. Aqueous extract from the twigs have shown promising effect on *P. falciparum* @39.86 μg/mL[90].

***Calotropis procera* (Aiton) Dryand.**, Milkweed, *Aak*, *Mudar*

Active principles - Calotropin, Calactin[91]

Calotropin is one of cardenolides isolated from milkweed used for medicinal purposes in many Asian countries. Calotropain (proteolytic enzyme isolated from the latex of *C. procera)* have potent anthelmintic activity against *Oesophagostomum columbianum* and *Bunostomum trigonocephalum* of sheep[92]. The latex has been shown to possess anthelmintic activity against *H. contortus* infection in sheep[93]. It is also effective against *Osetertagia*, *Nematodirus*, *Dictyocaulus*, *Teania*, *Ascaris a*nd *Fasciola*[94]**.** Ethanolic and aqueous extract of flower caused dose dependent paralytic effect on the trematode *Gastrothylax indicus*[95]. Ethanolic extracts of leaves, stems, roots, flowers and buds showed *in vitro* schizonticidal activity against chloroquine (CQ)-sensitive and CQ-resistant *P. falciparum* strains[96]. Similarly, n-hexane soluble portion of the chloroform extract of root bark of *C. gigantea* showed *in vitro* anti-amoebic activity against the HK-9 strain of *E. histolytica*[97]. Dry leaves of *C. procera* were found to be active against the malarial parasite[98]. *C. gigantea* was found to be active against amastigotes of *Leishmania major*[99]. Latex of *C. procera* containing acetogenins also showed anti-plasmodial activity and inhibitory effect on *P. falciparum*[100], *Leishmania* and *Trypanosoma* species[101]. Solvent extracts of aerial parts of *C. procera* showed antimalarial[102], antiproliferative and antiplasmodial activities[103]. Its herbal concoction showed anticoccidial activity against *Eimeria tenella* in broiler chickens[104]**.**

***Artemisia annua* L.**, Sweet wormwood, Annual wormwood, *Nagdona*, *Daman*

Active principles - Artemisinin, Quercetin[105]

Artemisinin is a sesquiterpene lactone containing an unusual peroxide bridge. This peroxide is believed to be responsible for the drug's mechanism of action. Artemisinin is isolated from the plant *A. annua*, an herb employed in Chinese traditional medicine. Precursor compound can also be produced by using genetically engineered yeast.

Artemisinin-derived drugs have been shown to be effective against many parasites like *F. hepatica* and

gastrointestinal nematodes in small ruminants such as *Plasmodium* spp., *Coccidia* spp., *Babesia* spp., *Leishmania* spp., *Neospora caninum* and *Schistosoma* spp.[106]. Artemisinin and its derivatives are used for both uncomplicated and severe *P. falciparum* malaria. *A. annua* tea was also effective against *Toxoplasma gondii,* although only 0.2 % artemisinin was present in tea[107]. Alcoholic extracts of *A. annua* also have trematocidal activity against adult *S. mansoni*, *F. hepatica*, and *Echinostoma caproni in vitro*[108]. *A. annua* leaf powder protected 70 % of infected chickens from mortality and pathological symptoms associated with *E. tenella*[109]. *A. annua* oil extract act as antimalarial repellent when used with eucalyptus, neem and Rose oil[110]. Artemisinin haxanolic extract showed antiplasmodial activity against *P. berghei* and it significantly inhibits the parasite *in vivo*[111].

***Pongamia pinnata* (L.) Pierre**, Indian beech, *Pongam oil tree*, *Karanja*

Active Principles - Karanjin, Pongapin, Kanjone, Pongaglabrone, Diketone pongamol, fatty acids, viz. Palmitic, Stearic, Arachidic, Behenic, Lignoceric, Oleic, Linole[112]

Karanjin, a furanoflavonol is a type of flavonoid obtained from the seeds of the *Karanja* tree [*P. pinnata* syn. *P. glabra* Vent., *Millettia pinnata* (L.) Panigrahi] growing wild in South India. Karanjin is an acaricide and insecticide which is used as biopesticide/bioinsecticide and is reported to have nitrification inhibitory properties. Fatty acids are straight chain hydrocarbons possessing a carboxyl (COOH) group at one end.

The ethanolic extracts of *P. pinnata* showed significant anti-plasmodial activity against *P. falciparum* when examined *in vitro*[113]. Aqueous and alcohol extracts of fruits and the alcohol extract of leaves caused inhibition of spontaneous movements of the whole worm and the nerve-muscle preparation of *Setaria cervi*[114]. *Neem* and *Karanja* oil cakes (individuals and combination) showed larvicidal activity against the mosquito species e.g. *C. quinquefasciatus*, *A. aegypti* and *Anopheles stephensi*[115].

***Achyranthes aspera* L.**, Prickly chaff-flower, *Latjeera, Chirchira*

Active principle - Triterpenoid saponins[116]

Triterpenoid saponins, the active constituents of *A. aspera* are triterpenes which belong to the group of saponin compounds. Many different plant species synthesize triterpenoid saponins as part of their normal growth and development.

Ethyl acetate extracts of *A. aspera* showed antiparasitic activity against the larvae of cattle tick *Rhipicephalus, B. microplus* and sheep gastrointestinal parasite *Paramphistomum cervi*[117]. Acetone, chloroform, ethyl acetate, hexane and methanol leaf extracts of *A. aspera* caused mortality of the early 4th instar larvae of *A. aegypti* and *C. quinquefasciatus* within 24 h[118]. Saponins from leaf extracts have larvicidal activity against *A. aegypti* and *Culex* sp. Ethyl acetate leaf extract was also found to be active against *Aedes subpictus* mosquito larvae[117]. The plant was reported to have activity in controlling mosquito larvae[119]. Larvicidal property against *A. aegypti* and *C. quinquefasciatus* was also shown by active principles present in essential oils obtained by steam distillation of leaf and stem extracts from *A. aspera*[42]. Saponin from leaf extracts has been reported to be active against *A. aegypti*[120].

***Moringa oleifera* Lam.**, Moringa, Drumstick tree, *Sahjan*

Active principles - Tannins, Flavonoids, Triterpenoids, Saponins and Alkaloids[121]

M. oleifera contains many active compounds like tannins, flavonoids, triterpenoids, saponins and alkaloids[121] having potent anthelmintic activity and its gum is being used as an anti-filarial agent[122]. The most targeted parasite species with the use of *M. oleifera* are helminths including *Dracunculiasis*, *Schistosomes* and *Trypanosomes*[123]. *In vitro* it has shown some antiprotozoan activity[124]. Seed extract containing lactin which hinders the process of larval development due to its haemagglutinating activity causes mortality in *A. aegypti*[125,126]. Aqueous extract of *M. oleifera* is known to have larvicidal, pupicidal as well as adult mosquito killer properties against the *C. quinquefasciatus*[127]. It is being used as antimalarial[128].

Discussion

Future prospects

There is need to explore phytochemicals through various research trials in animals because of great economic and socio-cultural advantages, especially in developing countries. The market prediction of phytomedicine is great because 80 % population of developing countries depends on herbal medicine. Traditional medicine needs support from Government for promotion and establishment of biotechnology industry for proper implementation. Therefore, herbal medicines should be standardized and regularized by implementing good policy frame work.

However, plant based anthelmentics have some limitations as some plants are available only in particular season and/or particular habitats. Another aspect is that collection of plant and extractions of active ingredients is tidious work and time intensive. Sometimes, in ethnomedicine preparation efficacious scientific proof like that of western paradigm is not followed.

Conclusion

Plant medicines have shown great efficacy against a varieties of parasites of medical and veterinary importance, the chance of drug resistance against phytoanthelmintics is also lesser than chemical anthelmintics. Therfore, phytomedicine are used as alternative methods to control livestock parasitism.

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