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Use of Medicinal Plants Against Parasitic Infections

Saurabh Singh Tomar[1], J. U. Patil[2], A.K. Jayraw[3], S. Yadav[4]

[1,4]Ph. D scholar, Department of Veterinary Parasitology, College of Veterinary Science & A.H., Mhow (Madhya Pradesh)
[2]Assistant Professor, Department of Veterinary Parasitology, College of Veterinary Science & A.H., Mhow (Madhya Pradesh)
[3]Professor, Department of Veterinary Parasitology, College of Veterinary Science & A.H., Mhow (Madhya Pradesh)

Abstract

Many of medicinal plants are called "ethnobotanicals" used in traditional homemade remedies that have been used for centuries in various regions. Some of the chemicals in plant extracts are well known and characterized (*e.g.* azadirachtin, citronella, nicotine, *etc*.) and can be considered as "natural" active ingredients. Some of these active ingredients have genuine insecticidal or anthelmintic properties (*i.e.* they actually kill some parasites). They are also known as biopesticides. Many of them act as repellent whereas some of them act as insecticide. Herb mixtures (dried, powdered, pelleted, *etc*.) are commercially available for preparing infusions or for direct feeding to livestock or pets, with various claims against external or internal parasites. Industrially produced plant extracts *(e.g.* citronella oil and neem oil) are usually well characterized and standardized (Benavides *et al*., 2001; Ismail *et al.*, 2002 and John *et al*. 2009). A common feature of most of these natural products is that they are not persistent. They are easily degradable (*e.g.* by sunlight) and/or rather volatile, or quickly metabolized and excreted, which are rather positive features regarding safety. For parasiticidal effect treatment has to be repeated frequently for constant protection of animals against parasites. Use of these herbal products against parasitic infections becomes mandatory owing to development of resistance against commonly used chemical anti-parasitic compounds. As the anti-parasitic resistance is the genetic ability of parasites to survive treatment with an anti-parasitic drug that was generally effective against those parasites in the past. After treatment with an anti-parasitic drug, the susceptible parasites die and the resistant parasites survive to pass on resistance genes to their offspring.

Introduction

Many of medicinal plants are called "ethnobotanicals" used in traditional homemade remedies that have been used for centuries in various regions. Some of the chemicals in plants extracts are well known and characterized (*e.g.* azadirachtin, citronella, nicotine, pyrethrins, *etc*.) and can be considered as "natural" active ingredients. Some of these active ingredients have genuine insecticidal or anthelmintic properties (i.e. they actually kill some parasites). They are also known as biopesticides. Others are more repellent than insecticides. Homemade remedies that produced at home in the kitchen, they are very complex mixtures of dozens of chemicals. Herb mixtures (dried, powdered, pelleted, *etc*.) commercially available for preparing infusions or for direct feeding to livestock or pets, with various claims against

external or internal parasites. Industrially produced plant extracts (e.g. cedar oil, citronella oil, neem oil). Such oils are usually well characterized and standardized, and normally they can be considered as 100% of "natural" origin. A common feature of most of these natural products is that they are not persistent. They are easily degradable (e.g. by sunlight) and/or rather volatile, or quickly metabolized and excreted, which are rather positive features regarding safety. But the parasiticidal effect lasts often only a few hours or days. This means that treatment has to be repeated rather frequently if the animals need constant protection.

***Allium sativum* (Garlic):** Onions and leaves contain alliin and allicin. In some regions it is used against lice. It is also recommended as a pet food capable of repelling ticks. It also shows efficacy against Ascarid roundworms and certain lungworms, but only as a preventive, because it does not prevent egg production by the worms in the intestine of the host, but only egg hatching in the host's feces. The anthelmintic effect seems to be due to its high sulfur content. It is used in some regions, mixed with other herbs. It can be mixed with food as fresh garlic or powdered. There are also garlic pills: 2 to 4 can be enough for lambs. For dairy animals it is recommended to administer it after milking, otherwise the milk will get garlic taste.

Table 1. Activity of *Allium sativum* against helminths

Plant	Scientific name	Part used	Target species	Reference
Garlic	*Allium sativum*	Bulb	*Bunostomum trigonocephalum*	Khobragade *et al.* (1994)
Garlic	*A. sativum*	Bulb/Oil	*Asaridia galli* and *Heterakis gallinarum*	Singh and Nagaich (2000)
Garlic	*A. sativum*	Bulb	*Haemonchus contortus*	Iqbal *et al.* (2001)
Garlic	*A. sativum*	Bulbils	*H. contortus*	Veerakumari and Lakshmi (2006)
Garlic	*A. sativum*	Bulb	*Fasciola gigantica* and *Gigantocotyle explanatum*	Singh *et al.* (2007)
Garlic	*A. sativum*	Bulb	*Fasciola gigantica*	Jeyathilakan *et al.* (2012)

***Annona squamosa* (Sitaphal)** is a small tree native to tropical America now found worldwide in the tropics. Powdered seeds and immature fruits can be administered topically to animals against fly larvae (myiases), lice and other insects.

Table 2. Activity of *Annona squamosa* against helminths

Plant	Scientific name	Part used	Target species	Reference
Sitaphal	*Annona squamosa*	Leaves	*H. contortus*	Mahore *et al.* (2007)

Table 3. Activity of *Annona squamosa* against protozoa

Plant	Scientific name	Part used	Target species	Reference
Sitaphal	*Annona squamosa*	Leaves	Promastigote and amastigote of Leishmania chagasi	Vila-Nova *et al.* (2011)

Sitaphal	*A. squamosa*	Seed	*Leishmania, Trypansoma, Plasmodium*	Ma *et al.* (2017)
Sitaphal	*A. squamosa*	Seed	Against promastigotes of three *Leishmania* species, epimastigotes of *Trypanosoma cruzi*	Osorio *et al.* (2017)

Table 4. Activity of *Annona squamosa* against arthropods

Plant	Scientific name	Part used	Target species	Reference
Sitaphal	*Annona squamosa*	Seed	*Clulex, Anopheles*	Ma *et al.* (2017)

***Azadirachta indica* (Neem):** is a tree native to the Indian subcontinent. Nowadays, it is found worldwide in tropical and sub-tropical regions. It contains azadirachtin, a vastly used biopesticide. Water and alcoholic extracts have shown promising efficacy against various ticks (e.g. *Boophilus, Amblyomma*, and *Rhipicephalus*) in field trials. In certain countries there are already commercial neem products for use on livestock. For domestic use, neem oil has a repellent effect against flies and other insects. It seems that it also works against mange mites. To get the oil, barked seeds are grinded to obtain a brown and sticky powder. This powder is mixed with water and the resulting paste is pressed to slowly obtain the oil. The leaves (preferably adult ones after fruiting) can also be left to soak in water for a few days.

Table 5. Activity of *Azadirachta indica* against helminths

Plant	Scientific name	Part used	Target species	Reference
Neem	*Azadirachta indica*	Seed	*Trichuris globulosa*	*Sarawal et al.* (2000)
Neem	*A. indica*	Leaves	*H. controtus*	*Singh et al.* (2008)
Neem	*A. indica*	Leaves	*H. controtus*	*Arora et al.* (2010)

Table 6. Activity of *Azadirachta indica* against protozoa

Plant	Scientific name	Part used	Target species	Reference
Neem	*A. indica*	Fruit	*Eimeria spp.*	Tipu *et al.* (2002)

Table 7. Activity of *Azadirachta indica* against arthropods

Plant	Scientific name	Part used	Target species	Reference
Neem	*A. indica*	Seed	*Ambyloma variegatum*	Ndumu *et al.* (1999)
Neem	*A. indica*	Seed and stem	*Boophilus microplus*	Benavides *et al.* (2001)
Neem	*A. indica*	Oil	*Rhipicephalus* spp.	Ismail *et al.* (2002)

***Butea frondosa* (Palash):** It is a flowering tree native to India and Southeast Asia which contains palasonine. There are reports on laboratory efficacy of leaves and seed extracts against some roundworms, tapeworms and flukes. Powdered seeds fed to sheep showed some efficacy against mixed infections with gastrointestinal roundworms.

Table 8. Activity of *Butea frondosa* against helminths

Plant	Scientific name	Part used	Target parasite	Reference (s)
Palas	*Butea frondosa*	Seeds	*Ascaridia galli*	Lal *et al.* (1976)
Palas	*B. frondosa*	Seeds	*A. Galli*	Sharma and Sisodia (1976)
Palas	*B.frondosa*	Seeds	*Ascaris lumbicoides*	Rao et al. (1977)
Palas	*B.frondosa*	Seeds	*Ascaridia galli*	Kumar *et al*. (1983)
Palas	*B. frondosa*	Seeds	*H. contortus*	Sathianesan *et al*. (1984)
Palas	*B. frondosa*	Seeds	*A. Galli*	Shilaskar and Parashar (1989)
Palas	*B. frondosa*	Seeds	*H. contortus*	Jangde *et al.* (2001)
Palas	*B. frondosa*	Seeds	*H. contortus*	Vihan *et al*. (2007)
Palas	*B. frondosa*	Seeds	*H. contortus*	Swarnkar *et al*. (2008)

***Carica papaya* (Papaya)**: is a fruit tree native to tropical America which contains benzyl isothiocyanate. Latex and seed extracts fed to chicken showed some efficacy against parasitic roundworms (*Heterakis gallinarum*, *Ascaridia galli*, *etc*.). The latex was used against various roundworms in the early 20th century.

Table 9. Activity of *Carica papaya* against helminths

Plant	Scientific name	Part used	Target species	Reference
Papaya	*Carica papaya*	Seed	*Ascaridia galli*	Lal *et al.* (1976)
Papaya	*C. papaya*	Seeds	*A. galli*	Rao and Krishnaiah (1982)
Papaya	*C. papaya*	Seed	*A .galli and Heterakis galiinae*	Singh and Nagaich (1999)
Papaya	*C. papaya*	Seeds	*H. contortus*, *Tricostrongylus* and *Oesophagostomum*	Ameen *et al.* (2018)

Papaya	*C. papaya*	Leaves	*P. cevri, H. contortus*	Islam *et al.* (2019)

Table 10. Activity of *Carica papaya* against protozoa

Plant	Scientific name	Part used	Target species	Reference
Papaya	*C. papaya*	Leaves powder	*E. tenella*	Hadimani and Gupta (2011)
Papaya	*C. papaya*	Seed	*Trypansoma cruzi*	Jiménez-Coello *et al.* (2013)
Papaya	*C. papaya*	Leaves	*E. tenella*	Dakapogan *et al.* (2018)

Table 11. Activity of *Carica papaya* against arthopods

Plant	Scientific name	Part used	Target species	Reference
Papaya	*C. papaya*	Seed	*Rhipicephalus* (*Boophilus*) *micr oplus*	Shyma *et al.* (2014)

***Cucurbita maxima* and *Cucurbita moschata* (Pumpkin):** It contains cucurbitacins. Aqueous or alcoholic seed extracts have shown some efficacy against *Haemonchus contortus* in laboratory studies. It is also used in traditional medicine to expel tapeworms. The seeds can be directly fed to livestock.

Table 12. Activity of *Cucurbita maxima* against helminths

Plant	Scientific name	Part used	Target species	Reference
Pumpkin	*Cucubita maxima*	Seed	*A. galli*	Feitosa *et al.* (2012)
Pumpkin	*C. maxima*	Fruit	*H. controtus*	Grzybek *et al.* (2016)
Pumpkin	*C. maxima*	Seed	*A. galli*	Abdel Aziz *et al.* (2018)
Pumpkin	*C. maxima*	Leaves	*Oesophagostomum*	Adzemye *et al.* (2019)
Pumpkin	*C. maxima*	Seed	Gastrointestinal nematodes	Acorda *et al.* (2019

***Cymbopogon nardus and Cymbopogon winterianus* (Citronella Grass or Lemon Grass):** are perennial grasses native to Asia, nowadays found worldwide in regions with tropical and temperate climate. The oil contains citronellal, geraniol, D-limonene, camphene, *etc*. The oil or single chemicals are widely used as insect repellents in numerous OTC products (shampoos, sprays, lotions, dusts, etc.) for pets.

Table 13. Activity of *Cymbopogon winterianus* against arthropods

Plant	Scientific name	Part used	Target species	Reference
Citronellal	*Cymbopogon winterianus*	oil	*culex*	Nerio *et al.* (2010)
Citronellal	*Cymbopogon winterianus*	oil	*Tabaniade*	Krcmr *et al.* (2016)

***Eucalyptus globulus* (Blue Gum):** is an evergreen tree native to Australia, nowadays vastly cultivated for industrial purposes in many parts of the world. Eucalyptus oil contains eucalyptol (=cineole), a vastly used biopesticide. Emulsifiable concentrates of the essential oil showed high efficacy against housefly larvae and pupae.

Table 14. Activity of *Eucalyptus globulus* against helminths

Plant	Scientific name	Part used	Target species	Reference
Blue gum	*Eukalyptus globulus*	Oil	Gastrointestinal nematodes	Freitas Macedo *et al.* (2011)
Blue gum	*E. globulus*	Oil	*H. contortus*	Katiki *et al.* (2017)

Table 15. Activity of *Eucalyptus globulus* against arthropods

Plant	Scientific name	Part used	Target species	Reference
Blue gum	*E. globulus*	Leaves	*Sarcoptes*	Fang *et al.* (2016)
Blue gum	*E. globulus*	Leaves	*Dermanyssus gallinae*	Elllse and wall (2014)

***Mentha piperita* (Peppermint):** is a perennial herbaceous plant (an hybrid of other Mentha species), native to Europe now found worldwide. Peppermint oil contains various biopesticides, such as caryophyllenes, D-limonene, menthone, menthol, pinenes, pulegone, etc. Emulsifiable concentrates of the essential oil showed high efficacy against houseflies in field studies.

Table 16. Activity of *Mentha piperita* against arthropods

Plant	Scientific name	Part used	Target species	Reference
Peppermint	*Mentha piperita*	Oil	*Ades,Anopheles,culex*	Ansari *et al.*(2000)

***Moringa oleifora* (Moringa or drumstick tree)**: is a small tree native to India. Flowers, leaves and fruits are used as food. Aqueous and alcoholic extracts showed efficacy against certain worms in laboratory studies.

Table 17. Activity of *Moringa oleifora* against helminths

Plant	Scientific name	Part used	Target species	Reference
Moringa	*Moringa oleifora*	Seeds	*H. contortus*	Gertrude *et al.*(2014)
Moringa	*M. oleifora*	Seeds	*H. contortus*	Delfin *et al.*(2017)

***Nicotiana tabacum* (Tobacco):** is a perennial herb (probably an hybrid of other species) native to America but nowadays cultivated worldwide. It is well known that tobacco plants contain nicotine, which is also a potent insecticide. Before the introduction of modern synthetic pesticides tobacco leaf extracts were vastly used as an agricultural pesticide. A water extract of leaves or any parts of the plant can be used for spraying livestock and pets against various external parasites. The juice of leaves seems to work as an insect repellent when rubbed on the body. Aqueous and alcoholic extracts showed *in vivo* efficacy

against gastrointestinal roundworms (*H. contortus*) on sheep. But the effective dose is very close to the toxic dose for livestock.

Table 18. Activity of *Nicotiana tabacum* against helminths

Plant	Scientific name	Part used	Target species	Reference
Tobacco	*Nicotiana tabacum*	Leaves	*H. contotus*	Raje and Jangde (2003)
Tobacco	*N. tabacum*	Leaves	*H. contotus*	Iqbal *et al.* (2006)

Table 19. Activity of *Nicotiana tabacum* against arthropods

Plant	Scientific name	Part used	Target species	Reference
Tobacco	*N. tabacum*	Leaves	*B. microplus*	Zaman *et al.* (2012)

***Nigella sativa* (Kala Jiri or Black Cumin)**: is a flowering plant native to Southwest Asia. Seed extracts showed some anthelmintic efficacy against tapeworms and some roundworms (e.g. *Oesophagostomum* spp.) in studies *in vitro* and in *vivo* on sheep.

Table 20. Activity of *Nigella sativa* against helminthes

Plant	Scientific name	Part used	Target species	Reference
Kala Jiri	*Nigella sativa*	Seeds/oil	*Taenia solium*	Agarwal *et al.* (1979)

***Neolamarckia cadamba* (Kadam):** is an evergreen tree native to Southeast Asia. Extracts of the bark showed some anthelmintic activity against certain parasitic roundworms and tapeworms in laboratory studies.

Table 21. Activity of *Neolamarckia cadamba* against helminths

Plant	Scientific name	Part used	Target species	Reference
Kadam	*Neolamarckia cadamba*	Stem	Gastrointestinal parasites	Kamal *et al.* (2015)

Table 22. Activity of *Neolamarckia cadamba* against arthropods

Plant	Scientific name	Part used	Target species	Reference
Kadam	*N. cadamba*	Leaves	*Anopheles stephensi*, *Aedes aegypti* and *Culex*	Ali and Venkatesalu (2020)

***Ocimum sanctum* (Tulsi)**: is an aromatic herb used in Indian traditional medicine. It contains eugenol. The essential oil showed efficacy against certain worms in laboratory studies.

Table 23. Activity of *Ocimum sanctum* against helminths

Plant	Scientific name	Part used	Target species	Reference
Tulsi	*Ocimum sanctum*	Leaves	*Ascaridia galli* and *Heterakis gallinarum*	Singh and Nagaich (2002)
Tulsi	*O. sanctum*	Leaves	*Ascaris suum*	Buchineri *et al.* (2015)

Tulsi	*O. sanctum*	Leaves	Gastrointestinal parasites	Kanojiya *et al.* (2015)

***Piper longum* (Indian Long Pepper or Pippali):** is a flowering vine native to Asia and cultivated for its fruits that are used as spice. Crude powder and aqueous extracts administered orally to goats showed some efficacy against gastrointestinal roundworms. In laboratory studies, the alcoholic fruit extract showed activity against *Toxocara cati* and the essential oil showed efficacy against *Ascaris lumbricoides*, a human parasite.

Table 24. Activity of *Piper longum* against helminths

Plant	Scientific name	Part used	Target species	Reference
Pippali	*Piper longum*	Fruit	Amphistomes	Singh *et al.* (2008)
Pippali	*P.longum*	Fruit	*Bunostomum* spp., trichostrongyles, *Oesophagostomum* spp. and *Haemonchus*	Jain and Sahni (2010)

***Punica granatum* (Pomegranate)**: is a tree native to Iran vastly cultivated for its fruits. Alcoholic bark extracts showed some efficacy against *Haemonchus contortus* larvae.

Table 25. Activity of *Punica granatum* against helminths

Plant	Scientific name	Part used	Target species	Reference
Pomegranate	*Punica granatum*	Fruit	*Gastrothylax*	Aggarwal *et al.* (2015)
Pomegranate	*P. granatum*	Fruit	Paraamphistome	Lalhmingchhuanmawii *et al.* (2014)

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