Anthelmintic Plants across the Globe

Subjects: Veterinary Sciences
Contributor: Haroon Ahmed , Seyma Gunyakti Kilinc , Figen Celik , Harun Kaya Kesik , Sami Simsek , Khawaja Shafique Ahmad , Muhammad Sohail Afzal , Sumaira Farrakh , Waseem Safdar , Fahad Pervaiz , Sadia Liaqat , Jing Zhang , Jianping Cao

Livestock production plays a key role in the economic development of a country. Helminthiasis caused by a helminth infection is a major constraint in global livestock production. The mortality and morbidity in animal populations owing to infections caused by parasitic helminths are rapidly increasing worldwide. These parasitic worms are categorized into two major groups: roundworms (phylum Nematoda) and flatworms (phylum Platyhelminthes). Among these parasites, gastrointestinal parasites pose a serious threat to livestock production.

ethnomedicine anthelmintic medicinal plant helminth

1. Introduction

In recent decades, continuous and intensive use of synthetic anthelmintics has been the only method to control gastrointestinal nematodes. However, resistance to all available anthelmintic drug classes has been reported in livestock species. Resistance to an anthelmintic drug is often observed within a few years of introduction of the drug, indicating a remarkably high rate of resistance development, which likely results from a combination of large, genetically diverse parasite populations, and strong selection pressure for resistance. Plants are an ideal source of naturally occurring compounds that can be used as alternative dewormers in livestock [1]. Recently, some anthelmintics have demonstrated loss of efficacy owing to anthelmintic resistance [2]; as a result, parasitic load progressively increases, leading to high mortality and morbidity. Traditional use of medicinal plants for controlling helminth infections is more acceptable owing to the eco-friendly nature and sustainable supply of medicinal plants [3].

Table 1. List of anthelmintic plants and their extracts effective against flatworms (Platyhelminthes).

Parasite	Study Model	Plant Family	Plant Name	Plant Tissue	Extract	Effective Concentration and Mortality Rate (%)	Reference
Carmyerius spatiosus	In vitro	Leguminosae	*Cassia siamea*	Leaves and heartwood	Ethyl acetate extracts	Highest anthelminthic effect	[4]
		Plumbaginaceae	*Plumbago zeylanica*	Roots	n-butanol extract		

Parasite	Study Model	Plant Family	Plant Name	Plant Tissue	Extract	Effective Concentration and Mortality Rate (%)	Reference
		Plumbaginaceae	*Plumbago indica*	Roots	hexane, ethyl acetate, and n-butanol extract		
		Combretaceae	*Terminalia catappa*	Leaves	n-butanol and water extract		
Clonorchis sinensis	In vitro	Rosaceae	*Hagenia abyssinica*	Female flowers	Crude extract	5 h (100 µg/mL)	[5]
Echinococcus granulosus (protoscolex)				Fruits and leaves	Hydroalcoholic extracts	100%; killed protoscoleces (50 mg/mL in 10 min)	[1]
	In vitro	Anacardiaceae	*Pistacia atlantica*	Leaves and fruits	Hydroalcoholic extracts	0.1% concentration of fresh fruit extract (99.09 ± 1.27 mg/mL) and leaf extract (89.25 ± 18.42 mg/mL) had strong scolicidal effects in 360 min	[6]
	In vitro	Lamiaceae	*Salvia officinalis*	Aerial parts	Ethanolic extract	100% (6–8 days)	[7]
		Fabaceae	*Prosopis farcta*	Leaves	Ethanolic extract Crude alkaloids	25% scolicidal activity with a 500 mg/mL dose after 24 h 57% scolicidal activity with a 500 mg/mL dose after 24 h	[8]
		Ranunculaceae	*Nigella sativa*	Seeds	Essential oil (Thymoquinone)	100% scolicidal activity with a	[9]

Parasite	Study Model	Plant Family	Plant Name	Plant Tissue	Extract	Effective Concentration and Mortality Rate (%)	Reference
						1 mg/mL dose after 10 min	
		Cucurbitaceae	*Dendrosicyos socotrana*	Leaves	Aqueous and methanolic extracts	100% scolicidal activity with a 5000 µg/mL dose after 360 h (methanolic extract) and 408 h (aqueous extract)	[10]
		Euphorbiaceae	*Jatropha unicostata*		Aqueous and methanolic extracts	100% scolicidal activity with a 1000 µg/mL dose after 288 h (both extracts)	
		Berberidaceae	*Berberis vulgaris*	Fruits	Aqueous extracts	98.7% scolicidal activity with a 2 mg/mL dose after 30 min	[11]
		Euphorbiaceae	*Mallotus philippinensis*	Fruits	Methanolic extracts	99% scolicidal activity with a 20 mg/mL dose after 60 min	[12]
Echinococcus granulosus protoscolex	In vitro	Meliaceae	*Azadirachta indica*	Whole plant	Ethanolic extracts	Up to 97% mortality with 30 min of incubation	[13]
Echinostoma caproni	In vitro	Rosaceae	*Hagenia abyssinica*	Female flowers	Crude extract	51 h (100 µg/mL)	[5]
Fasciola hepatica	In vitro	Fabaceae	*Acacia farnesiana*	Leaves	Hexane, ethyl acetate, and methanolic extracts	0% (500 mg/L)	[14]

Parasite	Study Model	Plant Family	Plant Name	Plant Tissue	Extract	Effective Concentration and Mortality Rate (%)	Reference
		Asteraceae	*Artemisia absinthium*			0% (500 mg/L)	
			Artemisia mexicana			100% (500 mg/L)	
		Papaveraceae	*Bocconia frutescens*			100% (500 mg/L)	
		Fabaceae	*Cajanus cajan*			100% (500 mg/L)	
		Boraginaceae	*Cordia* spp.			0% (500 mg/L)	
		Malvaceae	*Hibiscus rosa sinensis*			0% (500 mg/L)	
		Verbenaceae	*Lantana camara*			100% (500 mg/L)	
		Fabaceae	*Leucaena diversifolia*			0% (500 mg/L)	
		Meliaceae	*Melia azedarach*			13% (500 mg/L)	
		Lamiaceae	*Mentha* sp.			0% (500 mg/L)	
			Ocimum basilicum			0% (500 mg/L)	
		Piperaceae	*Piper auritum*			100% (500 mg/L)	
		Dysphania	*Teloxys ambrosioides*			0% (500 mg/L)	
Fasciola larvae (sporocyst, redia, and cercaria)	In vitro	Rosaceae	*Potentilla fulgens*	Dried root powder	Ether, chloroform, methanolic, acetone, and ethanolic extracts	8 h LC50 was 54.20 mg/L for sporocysts, 49.37 mg/L for redia, and 38.13 mg/L for cercaria	[15]

Parasite	Study Model	Plant Family	Plant Name	Plant Tissue	Extract	Effective Concentration and Mortality Rate (%)	Reference
Fasciola gigantica larvae (sporocysts, redia, and cerceria)	In vivo	Asparagaceae	*Asparagus racemosus*	Dried root powder	Ether, chloroform, methanolic, acetone, and ethanolic extracts	2 h LC50 was 79.93%	[16]
Fasciola gigantica and *Taenia solium*	In vitro	Euphorbiaceae	*Acalypha wilkesiana*	Extracts	Methanolic extracts of leaves, stems, and roots	All extracts exhibited anthelmintic activity in vitro	[17]
Fasciola hepatica	In vitro	Rosaceae	*Hagenia abyssinica*	Female flowers	Crude extract	1 h (100 µg/mL)	[5]
Fasciolopsis buski	In vitro	Zingiberaceae	*Alpinia nigra*	Shoot	Crude alcoholic extract	3.94 ± 0.06 h death time (20 mg/mL concentration)	[18]
Gastrothylax crumenifer	In vitro	Fabaceae	*Sesbania sesban var. bicolor*	Fresh leaves	Methanolic extracts of dried plants	Better than praziquantel	[19]
		Cyperaceae	*Cyperus compressus*	Roots			
		Asparagaceae	*Asparagus racemosus*	Roots			
Hymenolepis diminuta and *Syphacia obvelata*	In vitro In vivo	*Asparagaceae*	*Asparagus racemosus*	Roots	Methanolic extract	53.88% and 24% reduction in EPG * and worm counts, respectively (30 mg/mL concentration)	[20]
Hymenolepis diminuta	In vitro	Cyperaceae	*Cyperus compressus*	Roots	Methanolic extract	61.74% reduction in the EPG and 24% reduction in worm counts (30 mg/mL concentration)	[21]

Parasite	Study Model	Plant Family	Plant Name	Plant Tissue	Extract	Effective Concentration and Mortality Rate (%)	Reference
Hymenolepis diminuta	In vitro	Fabaceae	*Sesbania sesban*	Fresh Leaves	Methanolic extract	65.10% reduction in EPG counts, 56% reduction in worm counts (30 mg/mL concentration)	[22]
Paramphistomum gracile	In vitro	Fabaceae	*Senna alata*, *S. alexandrina*, and *S. occidentalis*	Leaf extract	Ethanolic extracts	Dose-dependent effects on motility and mortality	[23]
Paramphistomum microbothrium	In vitro	Zygophyllaceae	*Balanites aegyptiaca*	Fruits	Methanolic extract	200 µg/ml, at which distinct damage to the whole body surface of the trematodes	[24]
Raillietina echinobothrida	In vitro	Asteraceae	*Acmella oleracea*	Leaves	Methanolic extract	18.42 ± 0.95 h survival time (20 mg/mL concentration)	[25]
Raillietina spiralis	In vitro	Malvaceae	*Thespesia lampas*	Roots	Aqueous extracts	51 ± 0.33 min death time (20 mg/mL concentration)	[26]
Raillietina spiralis	In vitro	Meliaceae	*Azadirachta Indica*	Leaves	Aqueous extract	46 ± 0.53 min death time (20 mg/mL concentration)	[27]
Raillietina spiralis	In vitro	Scrophulariaceae	*Verbascum Thapsus*	Fresh Leaves	Methanolic extract	86 ± 5 min death time (20 mg/mL concentration)	[28]
Raillietina spiralis	In vitro	Asteraceae	*Achillea wilhelmsii*	Fresh Leaves	Methanolic extract	40 min death time (20	[29]

Medicinal plant extracts have long been used against helminth parasites in humans and livestock; however, scientific support for their application and research on the characterization of active composites remains limited [40]. Numerous studies have investigated anthelmintic resistance, especially in small ruminants. Most studies have used the fecal egg count reduction test (FECRT), which is based on field management practices. Nevertheless, in vivo experiments on drug efficacy have been conducted in areas with high economic importance. Notably, sheep have been studied more extensively than other livestock species, and a broad spectrum of therapeutics have already been developed for sheep [41].

Parasite	Study Model	Plant Family	Plant Name	Plant Tissue	Extract	Effective Concentration and Mortality Rate (%)	Reference
						mg/mL concentration)	
Raillietina spiralis	In vitro	Lauraceae	*Cinnamomum camphora*	Leaves	Aqueous extracts	47 ± 0.54 min death time (20 mg/mL concentration)	[30]
Raillietina spiralis	In vitro	Verbenaceae	*Clerodendron inerme*	Leaves	Aqueous extracts	45 ± 0.52 min death time (20 mg/mL concentration)	[31]
Raillietina tetragona	In vitro	Poaceae	*Imperata cylindrica*	Underground parts (rhizomes and roots)	Chloroform (medium polar solvent)	Dose-dependent anthelmintic activity	[32]
Schistosoma mansoni	In vitro	Apocynaceae	*Rauwolfia vomitoria*	Stem bark and roots	Ethanolic extract	High activity against cercariae and adult worms	[33]
Syphacia obvelata	In vitro	Cyperaceae	*Cyperus compressus*	Roots	Methanolic extract	28.92% reduction in the EPG and 33.85% reduction in worm counts (30 mg/mL concentration)	[21]
Syphacia obvelata	In vitro	Fabaceae	*Sesbania sesban*	Fresh leaves	Methanolic extract	EPG and worm counts reduced by 34.32% and 47.08%, respectively (30 mg/mL concentration)	[22]
Schistosoma mansoni	In vivo	Asteraceae	*Baccharis trimera*	Leaves	Crude dichloromethane extract (DE) and aqueous fraction (AF)	98% (AF) 97% (DE)	[34]

tic drugs, limited or no risk of resistance development, and environmentally friendly procedure [39]. A major drawback is that, to date, only a small number of anthelmintic compounds such as macrocyclic lactones, cyclic octadepsipeptides, benzimidazoles, and imidazothiazoles have been identified in plants after decades of research [55]. Another drawback is the inconsistency between in vitro and in vivo studies on the use of plants as anthelmintics, raising questions regarding their validity and reliability [56]. Additionally, neurological effects associated with the dosage and bioavailability of some medicinal plants need to be elucidated before their use. The choice of an appropriate host–parasite system is tricky in in vivo studies because caring for the animal models adequately is expensive, time-consuming, and labor-intensive [57]. Other drawbacks include uncertainty about plant efficacy, nonspecific responses, irreproducible preparations, and potential negative

Parasite	Study Model	Plant Family	Plant Name	Plant Tissue	Extract	Effective Concentration and Mortality Rate (%)	Reference
			Tanacetum vulgare	Aerial parts	Crude extract and Essential oil	100%	[35]
Schistosoma mansoni	In vitro	Rosaceae	*Hagenia abyssinica*	Female flowers	Crude extract	3 h (100 µg/mL)	[5]
Schistosoma mansoni	In vitro	Euphorbiaceae	*Euphorbia conspicua*	Leaves	Leaf extract	100% (100 µg/mL)	[36]
		Piperaceae	*Piper chaba*	Fruits	Methylene chloride extract	Strongest activity	[37]
Taenia solium	In vitro	Asclepiadaceae	*Pergularia daemia*	Leaves	Ethanolic extract	210.00 ± 0.52 min death time (25 mg/mL concentration)	[38]
					Aqueous extract	221.12 ± 0.61	
Taenia tetragona	In vitro	Asteraceae	*Acmella oleracea*	Leaves	Hexane extract	The lethal concentration (LC50) of the plant extract was 5128.61 ppm on *T. tetragona* and 8921.50 ppm on *A. perspicillum*	[39]

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