Chapter

Medicinal Plants Used for the Treatment and Management of Bilharziasis and Other Parasitic Infections Affecting Humans in Zimbabwe: A Systematic Review

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Abstract

The World Health Organization (WHO) estimated that at least 251.4 million people from 78 countries were in need of preventative care for bilharziasis in 2021. Globally, soil-transmitted helminth infections are present in at least 24% of the world's population. Tropical and subtropical areas have a wide distribution of infections with a high prevalence in the sub-Saharan Africa. The aim of this study was to document plants that have been traditionally used in Zimbabwe to manage bilharziasis and other parasitic infections. The literature review was based on published papers and abstracts retrieved from the online databases. Books, book chapters, scientific reports and theses from universities in Zimbabwe that were available online were also used in this review. Plants with the reported traditional usage against bilharziasis and other parasitic infections were recorded from the data retrieved. In total, 68 species were used to treat and manage bilharzia and other parasitic infections. Most of these medicinal plants were used to treat and manage schistosomes (fluke or worm). A total of 76.5% of the medicinal plants reported have been scientifically validated and documented to exhibit anthelmintic activity. In conclusion, Zimbabwe has a plethora of medicinal plants that can be used to manage bilharziasis and other parasitic infections.

Keywords: ethnobotanical, bilharzia, schistosomiasis, worms, pharmacological, toxicology, traditional plants, anthelmintic, Zimbabwe

1. Introduction

Schistosomiasis is a neglected parasitic tropical disease caused by blood flukes (trematode worms) of the genus Schistosoma. According to WHO [1] estimates, at least 251.4 million people reported from 78 countries were in need of preventative care for bilharziasis in 2021. Schistosomiasis, a disease caused by *Schistosoma mansoni* (intestinal) and *S. haematobium* (urogenital) species, is mainly concentrated in sub-Saharan Africa, where about 90% of the disease burden exists. The transmission of these species occurs through feces and urine, respectively [2]. Endemic areas where the infection is prevalent are inhabited by over 700 million people, particularly in tropical and subtropical regions. Schistosomiasis is more prevalent in impoverished rural communities, particularly in regions where fishing and agricultural activities are prevalent. These areas are often characterized by poor communities lacking access to potable water and adequate sanitation [3]. Morbidity reduction can therefore be accomplished with the use of preventative therapy, which should be repeated over a number of years in endemic areas with moderate to high transmission [4]. According to WHO [5] the most frequent illnesses worldwide are soil-transmitted helminth (STH) infections, which mostly afflict the poorest and most destitute populations. Where sanitation is inadequate, the soil is polluted with egg-infected human feces and fecal waste [5]. The primary causative species that infect humans are whipworms (*Trichuris trichiura*), hookworms (*Ancylostoma duodenale, Necator americanus* and *Ancylostoma duodenale*) and roundworms (*Ascaris lumbricoides*) [6]. STH infections afflict at least 24% of the world's population, which exceeds 1.5 billion individuals. Infections are widely distributed in tropical and subtropical locations, with the Americas, China, East Asia and sub-Saharan Africa having the highest frequency [5].

Pharmacotherapy is the most effective approach for decreasing the incidence of schistosomiasis infections. The WHO recommends preventive chemotherapy using praziquantel as the strategy for managing schistosomiasis. School-age children (5 to 15 years old) are the target population for this therapy due to their high infection burden and ability to be effectively targeted through schools [7]. Zimbabwe aims to eradicate bilharzia and intestinal worms, by 2030. During a mass treatment campaign carried out from April 3–9, 2022, over 1.8 million children received free oral treatment for schistosomiasis (bilharzia) and soil-transmitted helminthiases (intestinal worms) [8].

Despite not achieving complete elimination of bilharzia, Zimbabwe has significantly reduced the burden of the disease through the annual national treatment campaigns. In 2014 a study revealed that the district of Chiredzi in Masvingo province had the highest prevalence of *S. mansoni* at 43.7%, followed by the Hwedza district in Mashonaland East and Nyanga in Manicaland province, with prevalence rates of 32.3 and 31.5%, respectively [9]. Despite the great prevalence of parasitic diseases worldwide and the substantial amount of suffering caused by these parasites, the majority are considered neglected diseases. Only malaria treatment and prevention receive significant financing, but there is an urgent need for more action to be done to alleviate the suffering of the large populations of people who are infected with other parasitic diseases [10]. Similarly, despite those parasitic infections accounting for more than 10% of the world's disease burden, drug discovery efforts for parasitic diseases are limited, with only 1% of new medications addressing parasitic diseases in the last 40 years [6].

The purpose of the study is to find medicinal plant species that are used as an effective treatment against schistosomiasis in Zimbabwe. The study involved the compilation of a list of medicinal plants used in Zimbabwe to treat parasitic infections

in humans. Bilharzia, gastrointestinal worms and helminths, ectoparasites, trichomoniasis, leishmaniasis and trypanosomiasis are among the diseases covered. Due to the broad scope of these topics, veterinary usage and malaria were excluded. This systematic review will create a comprehensive digital database of medicinal plants used in traditional practice which holds the potential to expand treatment options, improve access to healthcare, preserve traditional knowledge and promote sustainable practices in disease management. Moreover, the potential development of drug resistance has sparked an ongoing debate about the future efficacy of praziquantel. The emergence of drug-resistant strains of schistosomes will pose a significant challenge in controlling the disease. Thus, exploring medicinal plants may help to identify novel compounds that can overcome drug resistance and provide alternative treatment options.

2. Objectives

This systematic review was therefore undertaken to:

1. Determine the medicinal plants traditionally used in Zimbabwe for the management of parasitic infections.

2. Describe the common names, scientific names, plant family, plant parts used, modes of preparation, traditional uses, distribution and conservation status.

3. Compile a comprehensive document that describes the ethnobotany of medicinal plants in Zimbabwe that are traditionally used to treat and manage parasitic infections in humans.

4. Generate integrated and sufficient traditional evidence to support its medicinal use.

5. Determine the endangered medicinal plant species to prioritize for conservation amidst the growing destruction of natural resources for settlement, industrialization, construction and energy production [11–13].

2.1 Inclusion criteria

Plants used to treat the following parasitic infectious diseases were included in this study

1. Bilharzia

2. Gastrointestinal worms

3. Helminths

4. Ectoparasites

5. Trichomoniasis

6. Leishmaniasis

7. Typanosomiasis

2.2 Exclusion criteria

Plants used to treat the following parasitic infectious diseases were excluded from this study

1. Malaria

2. Veterinary parasites

3. Materials and methods

3.1 Research protocol and reporting

The Preferred Reporting Items for the Systematic Reviews and Meta-Analyses (PRISMA) guidelines were used in the reporting of this study (**Figure 1**). The protocol used in this systematic review was as previously reported [14].

3.2 Literature search

Electronic data on the ethnobotany of medicinal plants used in Zimbabwe were retrieved from electronic databases such as Google, Google Scholar, Springer Link, Researchgate, PubMed, Science Direct and JSTOR. The keywords set "medicinal plants AND (antiparasitic OR antihelmintic) AND Zimbabwe" were used. The retrieved articles were downloaded and stored in EndNote X9 (Thomson Reuters, San Francisco, CA and USA). Duplicate articles were then removed from the file. Further, a manual search from the reference lists of screened eligible articles and deposited electronic copies of dissertations and theses in online Universities' repositories and National Herbarium and Botanic Gardens (SRGH) libraries up to 31 December 2020 were done. Other sources utilized in this study included books [15–18], book chapters, scientific reports and theses available at universities [19, 20] and National Herbarium and Botanic Gardens (SRGH) libraries. The authors continuously received notifications of any new "similar reports" meeting the search criteria from Science Direct, Scopus and Google Scholar.

The plant names were verified with http://www.theplantlist.org and https://www.zimbabweflora.co.zw. Plants with the reported traditional usage against bilharziasis and other parasitic infections were identified and compiled from the information collected and gathered. A master list was prepared including all the medicinal plants used in Zimbabwe for the treatment and management of bilharziasis and other parasitic infections (**Table 1**). The above-mentioned databases were also searched for pharmacological and toxicological properties providing scientific evidence of medicinal usage comparable to their ethnomedicinal usage. All the information was summarized in three tables (**Tables 1-3**) and five figures (**Figures 2-6**). The review excluded medicinal plants for veterinary use and those against malaria to limit the plants to those used in the treatment and management of bilharziasis and other parasitic infections in humans.

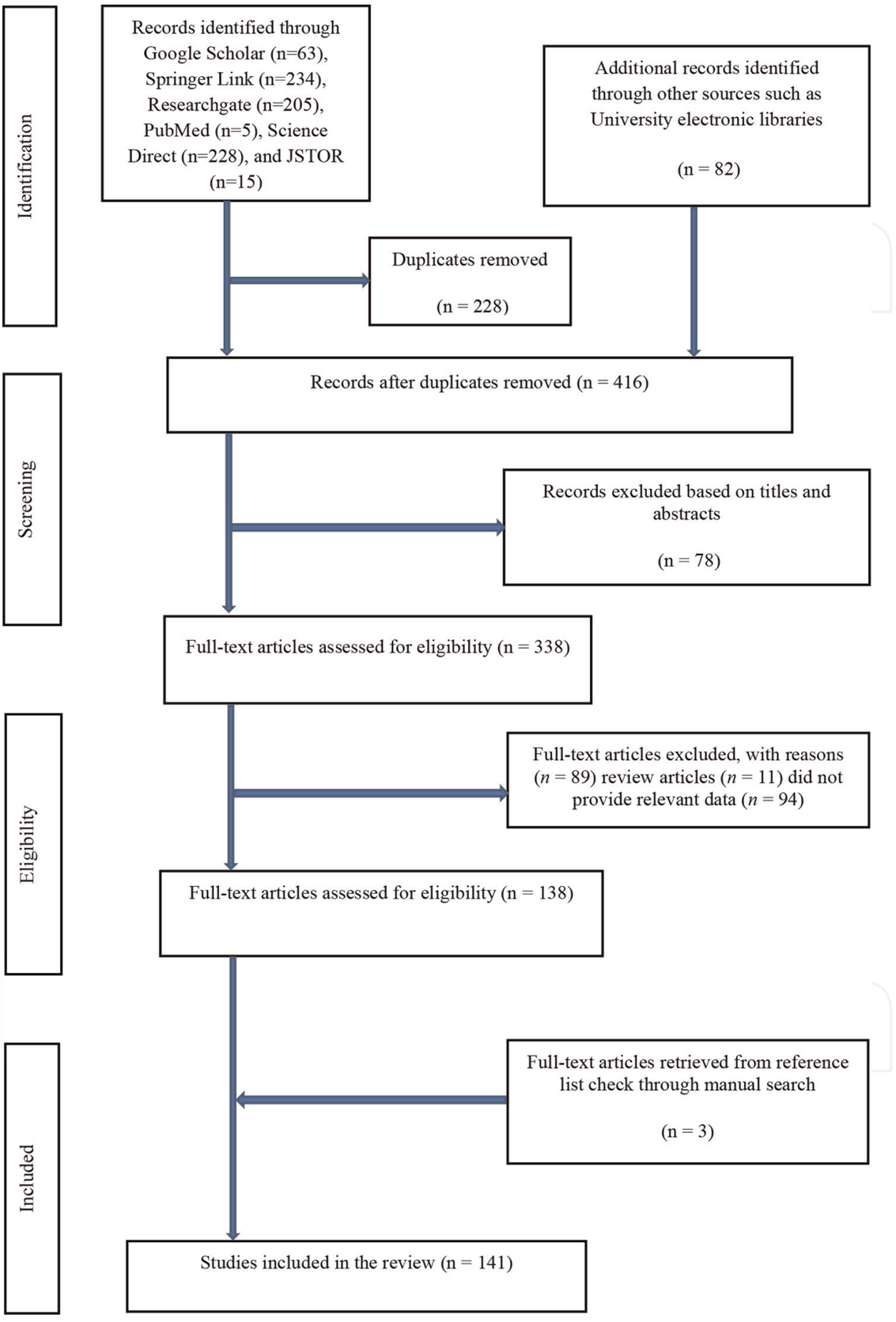

Figure 1.
PRISMA flow diagram showing the search and retrieval steps of the study (adopted from Moher et al. [14]).

Scientific name [Family]	[Growth habit] Distribution	Vernacular names and other names	Parts used and mode of preparation	Parasitic infection ethnomedicinal uses [References]
Abrus precatorius L. subsp. *africanus* Verde. [Fabaceae]	Woody, deciduous climber. [Climber] N, W, C, E, S	Chonjo (Shona) Lucky bean creeper (English) Minimini (Shona) Munhutuwaro (Shona)	Roots (fresh) Leaves and stem	Bilharziasis (Urinary schistosomiasis) [21–23]
Acacia karoo Hayne [Fabaceae]	Small to medium-sized tree. [Tree] N, W, C, E, S	Isinga (Ndebele) Mubayamhondoro (Shona) Muhunga (Shona) Muzunga (Shona) Sweet thorn (English)	Leaves and roots Roots decoction	Bilharziasis (Urinary schistosomiasis) [21, 23, 24]
AIbizia amunesiana Harms [Fabaceae]	Small to medium-sized tree. [Tree] N, W, C, E, S	Muriranyenze (Shona) Purple-leaved albizia (English) Umnonjwana (Ndebele)	Roots, bark, leaves and stem.	Bilharziasis (Urinary schistosomiasis) [21, 23]
Asparagus spp except *A. asparagoides L* [Asparagaceae]	Perennial herbs or shrubs [Herb or shrub] N, W, C, E, S		Roots – mixed with seeds of *Vigna unguiculata* in soup and taken orally.	Bilharziasis [16]
Burkea africanus Hook. [Fabaceae]	Deciduous tree, to 8 m. [Tree] N, W, C, E, S	Burkea (English) False ash (English) Mukarati (Shona) Umnondo (Ndebele) Wild syringa (English)		Bilharziasis (Urinary schistosomiasis) [21]
Carissa spinarum L. *Carrisa edulis* Vahl [Apocynaceae]	Scrambling shrub or small tree. [Tree] N, W, C, E, S	Mudyabveni (Shona) Mudzambara (Shona) Muhlababzunzi (Shona) Mumbingwa (Shona) Muruguru (Shona) Mutsamviringa (Shona) Simple-spined num-num (English) Umlugulu (Ndebele)		Bilharziasis (Urinary schistosomiasis) [21]
Cassia abbreviata Oliv. [Fabaceae]	Shrub or small rounded tree. [Tree] N, W, C, E, S	Isihaqa (Ndebele) Long-tail cassia (English) Muremberembe (Shona) Muvheneka (Shona)	Leaves, roots and bark.	Bilharziasis (Urinary schistosomiasis) [21, 23]
Catunaregam swynnertonii (S. Moore) Bridson *Catunaregum spinosa sensu* Verdcourt subsp. *spinosa* [Rubiaceae]	Spiny, deciduous shrub or small tree growing up to 7 metres. [Tree or shrub] E, S	Sand bone-apple (English)	Leaves	Intestinal worms [25]
Celtis africana Burm. f. [Ulmaceae]	Deciduous tree 5–15(−35) m [Tree] [Cultivated]	Common celtis (English) Kamutuna (Shona) Mugara (Shona) Muguru (Shona) Mukonachando (Shona) Musvutaderere (Shona) Umdlawuthu (Ndebele) White stinkwood (English)	Leaves and roots.	Bilharziasis (Urinary schistosomiasis) [21, 23]

Scientific name [Family]	[Growth habit] Distribution	Vernacular names and other names	Parts used and mode of preparation	Parasitic infection ethnomedicinal uses [References]
Cissampelos mucronata A. Rich. [Menispermaceae]	Liane with a woody root stock [Liane] N, W, C, E, S	Hairy heartleaf (English) Heart-leaved vine (English) Nyakuta (Shona) Ruzambu (Shona)	Roots – infusion taken orally three times a day for three consecutive days.	Bilharziasis [16]
Cissus quadrangularis L [Vitaceae]	Succulent climbing herb with tendrils. [Climber] N, W, C, E, S	Murunjurunju (Shona) Muvengahonye (Shona) Renja (Shona)	Whole plant – crushed and applied on wounds.	To treat wounds infested with maggots [16]
Clerodendrum ternatum Schinz [Verbenaceae]	Suffrutex growing from an extensive rhizomatous woody roots stock [Herb] N, W, C, E, S	Dwarf cat's whiskers (English) Umalanjana (Ndebele) Umqotshanja (Ndebele)	Roots – are ground into powder and taken orally.	Tapeworm and hookworm. [16]
Combretum hereroense Schinz subsp. *heteroense* [Combretaceae]	Shrub or small tree. [Tree or shrub] N, W, C, E, S	Ithetshane (Ndebele) Mouse-eared combretum (English) Murovamhuru (Shona) Mutechani (Shona) Russet bushwillow (English)		Bilharziasis [26]
Combretum imberbe Wawra [Combretaceae]	Medium to large deciduous tree. [Tree] N, W, C, E, S	Leadwood (English) Monzo (Shona) Muchenarota (Shona) Mutsviri (Shona) Umtshenalotha (Ndebele) Umtshwili (Ndebele)	Roots – infusion taken orally.	Bilharziasis [16, 27]
Combretum zeyheri Sond [Combretaceae]	Small to medium-sized tree. [Tree] N, W, C, E, S	Large-fruited bushwillow (English) Muchenja (Shona) Mupembere-kono (Shona) Muruka (Shona) Umbhondo (Ndebele) Umbula (Ndebele)		Bilharziasis and hookworm [28]
Crossopteryx febrifuga (Afzel. ex G. Don) Benth [Rubiaceae]	Shrub or small deciduous tree. [Tree] N, W, C, E, S	Common crown-berry (English) Crystal-bark (English) Mubakatirwa (Shona) Mugoko (Shona) Mukombegwa (Shona) Mukombigo (Shona) Muteyo (Shona) Umphokophokwana (Ndebele)		Bilharziasis (Urinary schistosomiasis) [21]
Croton gratissimus Burch [Euphorbiaceae]	Shrub or small tree. [Tree or shrub] N, W, C, E, S	Gunukira (Shona) Lavender croton (English) Mubangwa (Shona) Mufandemengwe (Shona) Mufarata (Shona)		Internal worms and ascariasis [25]
Cynanchum viminale (L.) L. subsp. *viminale Sarcostemma*	Succulent vine. [Climber] N, W, C, E, S	Caustic vine (English) Chifure (Shona) Imvubu (Ndebele) Ingotsha (Ndebele) Ingotshayeganga	Latex – infusion taken orally.	Worm scours [16]

Scientific name [Family]	[Growth habit] Distribution	Vernacular names and other names	Parts used and mode of preparation	Parasitic infection ethnomedicinal uses [References]
viminale (L) R.Br [Apocynaceae]		(Ndebele) Milk rope (English) Runyakadomdo (Shona) Rusungwe (Shona)		
Dicoma anomala Sond. [Asteraceae]	Prostrate, decumbent or erect perennial herb [Herb] N, W, C, E, S	Fever bush (English) Stomach bush (English) Chifumuro (Shona)	Roots (fresh) decoction	Bilharziasis (Urinary schistosomiasis) Intestinal worm parasites [21–23, 29]
Diplorhynchus condylocarpon (Müll. Arg.) Pichon [Apocynaceae]	Shrub or as a small, graceful tree [Tree or shrub] N, W, C, E, S	Rhodesian rubber tree, Horn-pod tree, Wild rubber (English) Mutowa (Shona)		Bilharziasis (Urinary schistosomiasis) [21]
Elephantorrhiza goetzei (Harms) [Fabaceae]	[Shrub] N, W, C, E, S	Intolwane (Ndebele) Mugudzuru (Shona) Narrow-pod elephant roots (English) Ndorani (Shona)	Roots – is mixed with *Bauhinia thonningii* and a decoction is prepared which is taken orally. Roots decoction and/or infusion. Roots (fresh), fruits, stem bark and stem	Bilharziasis (Urinary schistosomiasis) [16, 21, 23, 30–32]
Eriosema englerianum Harms. [Fabaceae]	A many-stemmed perennial, growing from a woody root stock. [Herb] N, W, C	Blue bush (English) Mashona fire bean (English)	Roots – is mixed with *Vigna unguiculata* seeds and soup drunk.	Bilharziasis [16]
Erythrina abyssinica Lam. ex DC. [Fabaceae]	Small to medium-sized tree of wooded grassland. [Tree] N, C, E, S	Lucky-bean tree (English) Munhimbiti (Shona) Mutete (Shona) Mutiti (Shona) Mutsiti (Shona) Red-hot-poker tree (English) Umgqogqogqo (Ndebele)	Roots – is mixed with *Vigna unguiculata* seeds and soup drunk.	Bilharziasis (Urinary schistosomiasis) [16, 21]
Euclea divorum Hiern [Ebenaceae]	Evergreen shrub or small tree. [Tree or shrub] N, W, C, E, S	Diamond-leaved euclea (English) Magic guarri (English) Mubhununu (Shona) Mudziviriratsuro (Shona) Mugarazvuru (Shona) Muguramenо (Shona) Munyenya (Shona) Mushangura (Shona) Umtshekesane (Ndebele)	Roots – mixed with *Vigna unguiculata* seeds and cooked in soup.	Bilharziasis (Urinary schistosomiasis) [16, 21]
Euphorbia schinzii Pax [Euphorbiaceae]	Shrub under 2 m. [Shrub] N, W, C, E, S			Bilharziasis (Urinary schistosomiasis) [21]
Faurea saligna Harv [Proteaceae]	Small to medium-sized tree.	Mutsatstsi (Shona) African beech (English) Isidwadwa (Ndebele) Kapfutsana (Shona)	Leaves	Bilharziasis and helminthiasis. [33]

Scientific name [Family]	[Growth habit] Distribution	Vernacular names and other names	Parts used and mode of preparation	Parasitic infection ethnomedicinal uses [References]
	[Tree] N, W, C, E, S	Mugarahungwe (Shona) Munyaganza (Shona) Mushangwa (Shona) Muzazati (Shona) Umpembele (Ndebele) Willow beechwood (English)		
Flacourtia indica (Burm.f) Merr [Salicaceae]	Tree, shrub over 2 m. [Tree or shrub] N, W, C, E, S	Batoka plum (English) Governor's plum (English) Mududwe (Shona) Munhunguru (Shona) Mutombototo (Shona) Mutudza (Shona) Mutunguru (Shona)	Roots – infusion taken orally.	Bilharziasis and intestinal worms [16, 19, 20]
Gymnosporia senegalensis (Lam.) Loes. *Maytenus senegalensis* (Lam) Exell [Celastraceae]	Tree, shrub over 2 m. [Tree or shrub] N, W, C, E, S	Chivhunabadza (Shona) Chizhuzhu (Shona) Confetti tree (English) Isihlangu (Ndebele) Mugaranjiva (Shona) Mukokoba (Shona) Musosaguva (Shona) Musosawafa (Shona) Musukameno (Shona) Mutotova (Shona) Mutsotsova (Shona) Red spike-thorn (English)	Leaves and stem. Roots Roots and bark	Bilharziasis (Urinary schistosomiasis) [21, 23]
Hydnora abyssinica A. Braun ex Schweinf. *Hydnora solmsiana* Dinter [Hydnoraceae]	A subterranean roots parasite, lacking chlorophyll [Roots parasite] W, C	Emerging flower (English)		Bilharziasis (Urinary schistosomiasis) [21]
Khaya anthotheca (Welw.) C. DC. *Khaya nyasica* Bak. f. [Meliaceae]	Large to very large evergreen tree with a long straight stem. [Tree] N, E, S	Mubarwa (Shona) Mururu (Shona) Muwawa (Shona) Red mahogany (English)		Bilharziasis (Urinary schistosomiasis) [21]
Kigellia africana (Lam.) Benth. *Kigelia pinnata* (Jacq.) DC. [Bignoniaceae]	Medium to large tree. [Tree] N, W, C, E, S	Mubveve (Shona) Musonya (Shona) Muvhumati (Shona) Sausage tree (English) Umvebe (Ndebele)	Fruit, bark and roots.	Tapeworm [19]
Landolphia kirkii Dyer ex Hook. f. [Apocynaceae]	[Climber, liane.] E	Mukanga (Shona) Muungu (Shona) Rubber vine (English) Runyangarwapene (Shona) Sand apricot-vine (English)		Bilharziasis (Urinary schistosomiasis) [21]
Lannea discolor (Sond.) Engl. [Anacardiaceae]	Medium-sized deciduous tree. [Tree] N, W, C, E, S	Chizhenje (Shona) Live-long (English) Mugan'acha (Shona) Muhumbukumbu (Shona) Mumbumbu (Shona) Mupuri (Shona)	Roots – decoction taken orally. Leaves and stem. Roots and bark.	Bilharziasis (Urinary schistosomiasis) [21, 23, 34, 35]

Scientific name [Family]	[Growth habit] Distribution	Vernacular names and other names	Parts used and mode of preparation	Parasitic infection ethnomedicinal uses [References]
		Mushamba (Shona) Tree grape (English)		
Lannea edulis (Sond.) Engl. [Anacardiaceae]	Shrub under 2 m [Shrub] N, W, C, E, S	Intakubomvu (Ndebele) Mutsambatsi (Shona) Tsombori (Shona) Wild grape (English)	Roots – infusion or decoction taken orally. Roots can be ground into powder and mixed with porridge and taken orally. Roots (fresh) Leaves and stem.	Bilharziasis (Urinary schistosomiasis) [16, 21–23, 31, 36]
Lecaniodiscus fraxinifolias Bak. [Sapindaceae]	Tree, shrub over 2 m. [Tree or shrub] N, E, S	Chikuhlule (Hlengwe) Musando (Shona) Mutarara (Tonga: Zimbabwe) River-litchi (English)	Leaves and stem. Roots.	Bilharziasis (Urinary schistosomiasis) [21, 23]
Loranthus on *Dichrostachys cinerea,* [Loranthaceae]	Parasitic shrub with long spreading stems. [Shrub] N, W, C, E, S	Sicklebush (English)	Whole plant – infusion taken orally.	Bilharziasis [16]
Mondia whitei (Hook.f.) Skeels [Apocynaceae]	[Climber, liane] N, W, C, E, S	Mungurauwe (Shona) Tonic roots (English) White's ginger (English)	Roots – ground into powder and mixed in porridge.	Bilharziasis [16]
Mucuna coriacea Baker subsp. irritans (Burtt Davy) Verdc. [Fabaceae]	Climber, shrub over 2 m. [Climber or shrub] N, C, E, S	Buffalo bean (English) Huriri (Shona) Uriri (Shona)		Bilharziasis (Urinary schistosomiasis) [21]
Musa sp. [Musaceae]	Tall herbs, perennial [Herb] Cultivated	Mubhanana (Shona)		Bilharziasis (Urinary schistosomiasis) [21]
Ozoroa reticulata (Baker f.) R. Fern. & A. Fern. *Ozoroa insignis* Del. subsp. *reticulata (*Bak.f.) Gillett *Heeria reticulata* Engl. [Anacardiaceae]	A small, much-branched deciduous tree. [Tree] N, W, C, E, S	Isafice (Ndebele) Muacha (Shona) Mubedu (Shona) Mudyamombe (Shona) Mugaragunguwo (Shona) Mulilila (Tonga: Zimbabwe) Murungu (Shona) Raisin bush (English) Tar berry (English)	Roots – infusion mixed with porridge and taken orally. Roots – infusion taken orally. Roots (fresh) Leaves Stem and bark. Roots bark.	Tapeworm and hookworm. Bilharziasis (Urinary schistosomiasis) [16, 21–23]
Peltophorum africanum Sond. [Fabaceae]	Tree, shrub over 2 m. [Tree or shrub] N, W, C, E, S	African wattle (English) Dzedze (Shona) Mudjiza (Shona) Mupumhamauva (Shona) Musambanyoka (Shona) Mutandarombo (Shona) Muzeze (Shona) Nyakambariro (Shona) Nyamanyoka (Shona) Umkahla (Ndebele) Umsehla (Ndebele) Zeze (Shona)	Leaves and stem. Roots and roots bark. Roots	Bilharziasis (Urinary schistosomiasis) Intestinal parasites [21, 23, 29]
Phaseolus vulgaris L [Fabaceae]	Herbs or subshrubs, erect, prostrate	Common bean (English) French bean (English)	Seeds – dried	Bilharziasis (Urinary schistosomiasis) [21]

Scientific name [Family]	[Growth habit] Distribution	Vernacular names and other names	Parts used and mode of preparation	Parasitic infection ethnomedicinal uses [References]
	or climbing. [Herb or shrub] Cultivated			
Piliostigma thonningii (Schumach.) Milne-Redh. [Fabaceae]	[Tree] N, W, C, E, S	Camel-foot (English) Ihabahaba (Ndebele) Monkey bread (English) Mubaba (Shona) Muhuku (Shona) Musakasa (Shona) Musekesa (Shona) Mutukutu (Shona)	Roots – are mixed with *Elephantorrhiza goetzei* roots and an infusion are prepared which is taken orally. Leaves and stem. Roots and roots bark. Roots	Bilharziasis (Urinary schistosomiasis) [16, 21, 23, 31]
Pogonarthria squarrosa (Roem. & Schult.) Pilg. [Poaceae]	Erect perennial tufted grass, up to 1 m. [Grass] N, W, C, E, S	Cross grass (English) Herringbone grass (English) Meerjarige denneboomgras (Afrikaans) Sekelgras (Afrikaans)	Roots – decoction taken orally.	Bilharziasis [16]
Pterocarpus angolensis DC. [Fabaceae]	Tree, shrub over 2 m. [Tree or shrub] N, W, C, E, S	Bloodwood (English) Mubvamakovo (Shona) Mubvamaropa (Shona) Mubvinziropa (Shona) Mukambira (Shona) Mukonambiti (Shona) Mukula (Tonga: Zimbabwe) Mukurambira (Shona) Mukwa (English) Mukwa (Shona) Mukwirambira (Shona) Mushambaropa (Shona) Muzwamulowa (Tonga: Zimbabwe) Umvagazi (Ndebele)	Bark – infusion taken orally. Flowers – applied to incision on area affected. Roots (fresh) Leaves Stem Bark	Bilharziasis (Urinary schistosomiasis) [16, 21–23]
Ricinus communis L [Euphorbiaceae]	Tree, annual, perennial, shrub over 2 m, shrub under 2 m. [Tree or shrub] Introduced	Castor-oil plant (English)	Roots – infusion taken orally. Leaves and roots – infusion taken orally.	Bilharziasis (Urinary schistosomiasis) [16, 21, 37]
Sansevieria hyacinthoides (L.) Druce [Dracaenaceae]	Evergreen, perennial herb [Herb] N, C, E, S	Mother-in-law's tongue (English) Piles roots (English) Bowstring hemp (English)	Leaves, rhizome and roots.	Intestinal parasites and worms. [38]
Sclerocarya birrea (A. Rich.) Hochst. subsp. *caffra* (Sond.) Kokwaro [Anacardiaceae]	Medium-sized deciduous tree. [Tree] N, W, E, S	Marula (English) Mufuna (Shona) Mupfura (Shona) Mushomo (Shona) Umganu (Ndebele)	Roots – infusion taken orally. Bark	Bilharziasis [16, 19]
Securidaca longipedunculata Fresen [Polygalaceae]	Tree, shrub over 2 m. [Tree or shrub] N, W, C, E, S	Chipvufanana (Shona) Mufufu (Shona) Munyapunyapu (Shona) Munyazvirombo (Shona) Mutangeni (Shona) Umfufu (Ndebele) Violet tree (English)	Roots – infusion taken orally.	Tapeworm and hookworm. Bilharziasis (Urinary schistosomiasis) [16, 21, 37]
Senna italica Mill. subsp. *micrantha*	Prostrate or ascending	The Port Royal senna (English)		

Scientific name [Family]	[Growth habit] Distribution	Vernacular names and other names	Parts used and mode of preparation	Parasitic infection ethnomedicinal uses [References]
(Brenan) Lock *Cassia italica* (Mill.) F.W. Andr. [Fabaceae]	perennial herb or small shrub [Herb or shrub] W, C, S			Bilharziasis (Urinary schistosomiasis) [21]
Senna petersiana (Bolle) Lock *Cassia petersiana* Bolle [Fabaceae]	Tree, shrub over 2 m. [Tree or shrub] N, C, E, S	Eared senna (English) Monkey pod (English)		Bilharziasis (Urinary schistosomiasis) [21]
Senna singueana (Delile) Lock *Cassia singueana* Delile [Fabaceae]	Tree, shrub over 2 m. [Tree or shrub] N, W, C, E, S	Isihaqa esincinyane (Ndebele) Mudyamhungu (Shona) Munzungu (Shona) Mushayanyoka (Shona) Scrambled egg (English) Sticky pod (English) Winter cassia (English) Winter-flowering senna (English)	Leaves, stem, roots and bark.	Bilharziasis (Urinary schistosomiasis) [23]
Solanum campylacanthum Solanum delegoense Dunal *S. incanum* [Solanaceae]	[Shrub] Introduced	Nhundurwa (Shona) Bitter apple (English) Intume (Ndebele) Munhomboro (Shona) Munhundurwa (Shona) Poison apple (English) Snake apple (English) Sodom apple (English) Thorn apple (English) Umdulukwa (Ndebele)	Leaves Roots	Bilharziasis (Urinary schistosomiasis) [16, 21, 37]
Steganotaenia araliacea Hochst. [Apiaceae]	[Tree] N, C, E, S	Carrot Tree (English)	Leaves and stem. Roots and stem.	Bilharziasis (Urinary schistosomiasis) [38]
Strychnos occuloides Bak. [Loganiaceae]	Small deciduous tree. [Tree] N, W, E, S	Corky monkey-orange (English) Muhumi (Shona) Mushumwi (Shona) Mutamba muzhinyu (Shona)		Bilharziasis (Urinary schistosomiasis) [16, 19]
Terminalia brachystemma Welw. ex Hiern [Combretaceae]	Shrub or small semi-deciduous tree. [Tree or shrub] N, W, C, E, S	Kalahari cluster-leaf (English)	Leaves Roots Fruit	Bilharziasis (Urinary schistosomiasis) [16, 21, 37]
Terminalia sericea Burch ex. DC [Combretaceae]	Small to medium-sized deciduous tree. [Tree] Introduced	Mangwe (Shona) Mukonono (Shona) Mususu (Shona) Mutabvu (Shona) Silver cluster-leaf (English) Silver terminalia (English) Umangwe (Ndebele)	Roots – mixed with *Vigna unguiculata* seeds and cooked in soup. Roots – decoction taken orally.	Bilharziasis Worms in anus and arms. [16, 21, 37]
Toddalia asiatica (L.) Lam. *Toddalia aculeata* Pers. [Rutaceae]	[Climber, liane.] N, C, E, S	Chikafusi (Shona) Climbing orange (English) Cockspur orange (English) Gato (Shona) Mubhatakhamba (Ndau) Rukato (Shona)		Bilharziasis (Urinary schistosomiasis) [38]

Scientific name [Family]	[Growth habit] Distribution	Vernacular names and other names	Parts used and mode of preparation	Parasitic infection ethnomedicinal uses [References]
Trichilia emetica Vahl subsp. *emetica* *Trichilia roka* Chiov. [Meliaceae]	Medium-sized to large evergreen tree. [Tree] N, W, E, S	Banket mahogany (English) Muchichiri (Shona) Mutsikiri (Shona) Natal mahogany (English)	Leaves Roots and roots bark.	Bilharziasis (Urinary schistosomiasis) [16, 19]
Trichodesma ambacense Welw. subsp. hockii (De. Wild) Brummitt [Boraginanceae]	Perennial herb. [Herb] N, W, C, E, S	Blue Bells of St. Mary's (English) Gwiramwaka (Shona)	Tuber – is ground into powder and taken orally.	Bilharziasis [16, 21, 37]
Vangueria infausta Burch.subsp. *infausta* [Rubiaceae]	Small deciduous tree. [Herb] W, C, E, S	Munjiro (Shona) Munzviro (Shona) Munzvirwa (Shona) Umthofu (Ndebele) Umviyo (Ndebele) Velvet wild medlar (English)	Fruit, leaves and roots – decoction taken orally. Roots	Parasitic worms [29, 39] Roundworm
Vernonia amydalina Del [Asteraceae]	Tree, shrub over 2 m. [Tree or shrub] N, W, C, E, S	Bitter-tea vernonia (English) Dembezeko (Shona) Inyathelo (Ndebele) Musikavakadzi (Shona) Muzhozho (Shona) Nyareru (Shona) Tree vernonia (English)	Roots – are mixed with *Vigna unguiculata* seeds and a soup is prepared and taken orally. Leaves and stem. Roots. Roots bark	Bilharziasis (Urinary schistosomiasis) [16, 23]
Vernonia musofensis S. Moore var. *miamensis* (S. Moore) G.V. Pope *Vernonia philipsoniana* Lawaltree [Asteraceae]	[Herb] N, C, E		Roots – are mixed with *Vigna unguiculata* seeds and a soup is prepared and taken orally.	Bilharziasis
Warburgia sulcate [Canellaceae]	Evergreen tree. [Tree] No information			Bilharziasis [40]
Ximenia caffra Sond. [Olacaceae]	Tree, shrub over 2 m. [Tree or shrub] N, W, C, E, S	Munhengeni (Shona) Mutengeni (Shona) Mutsvanzva (Shona) Sourplum (English) Umthunduluka (Ndebele)	Roots – infusion taken orally. Roots (fresh) Leaves and stem. Roots bark.	Bilharziasis (Urinary schistosomiasis) [16, 21–23, 40]
Zanthoxylum chalybeum Engl. [Rutaceae]	Tree, shrub over 2 m. Tree or shrub N, W, C	Kundanyoka knobwood (English) Mukundanyoka (Shona)		Bilharziasis (Urinary schistosomiasis) [21]
Ziziphus mucronata Willd [Rhamnaceae]	Small to medium-sized tree. [Tree] N, W, C, E, S	Buffalo-thorn (English) Chinanga (Shona) Muchecheni (Shona) Umpasamala (Ndebele) Umphafa (Ndebele)	Roots – infusion taken orally. Leaves and stem Roots bark Roots	Bilharziasis (Urinary schistosomiasis) [16, 21, 23, 40]

Table 1.
Medicinal plants used to treat and manage bilharziasis and other parasitic infections in Zimbabwe: Family and botanical name, local name, part used, mode of preparation, growth form, distribution and ethnomedicinal uses.

Scientific name	Pharmacological properties	Biological target	Toxicological evaluation	Reference
Abrus precatorius L. subsp. *africanus* Verde.	*Anthelmintic, analgesic, antimicrobial, antimigraine, anti-bacterial, anti-fungal, anti-tumor, anti-spasmodic, anti-diabetic, anti-serotonergic and anti-inflammatory activities.	Cestodes Schistosomes	Safe LD_{50} > 5000 mg/kg	[23, 45–50]
Acacia karoo Hayne	Analgesic, HIV1 reverse transcriptase, antilisterial, anti-gonococcal, anti-diabetic, anti-inflammatory, antioxidant, antibacterial, antifungal, antimalarial, antimicrobial, *anthelmintic and anti-mycobacterial activities.	Cestodes	Weak or low toxicity or mildly toxic LD_{50} < 1600 mg/kg	[23, 51–53]
AIbizia antunesiana Harms	*Anthelmintic and oxidant activities.	Cestodes	no records found	[23, 31, 54]
Asparagus spp except *A. asparagoides L*	Analgesic, diuretic, *anthelmintic, anti-inflammatory and antimicrobial activities.	Nematodes: *Haemonchus contortus*	Safe LD_{50} > 5000 mg/kg	[55–58]
Burkea africanus Hook.	Antioxidant, anti-diarrhoeal, antibacterial, analgesic, anti-inflammatory, anti-cholinesterase and *anthelmintic activities.	Nematodes: *Haemonchus contortus*	Safe LD_{50} > 5000 mg /kg	[59–61]
Carissa spinarum L. *Carrisa edulis* Vahl	Anti-plasmodial, diuretic, antioxidant, *antihelmintic, antiherpetic, anti-inflammatory and antiviral activities.	Earthworms: *Pheretima posthuma.*	Safe LD_{50} > 2000 mg in rats	[62–66]
Cassia abbreviata Oliv.	*Anthelmintic, antiviral, antioxidant, antimicrobial, abortifacient, anti-diabetic, anti-inflammatory, hepatoprotective and antimicrobial activities.	Cestodes	Safe LC_{50}– 1319.37 ± 356.63 μg/ml	[23, 67–72]
Catunaregam swynnertonii (S. Moore) Bridson *Catunaregum spinosa sensu* Verdcourt subsp. *spinosa*	*Anthelmintic, antioxidant, emetic, nauseant, anti-allergic, antipyretic, anti-inflammatory, expectorant, abortifacient, antibacterial, human cyclooxygenase (COX)-2 inhibitory effects, analgesic, immunomodulatory and a prominent protection of DNA activities.	Nematodes Earthworm: *Eisinia Fetida*	Safe LD_{50} up to 2000 mg/kg.	[60, 73, 74]

Scientific name	Pharmacological properties	Biological target	Toxicological evaluation	Reference
Celtis africana Burm. f.	*Anthelmintic, prokinetic, laxative, antidiarrheal, spasmolytic, antioxidant, anti-inflammatory andweak to moderate acetylcholinestrease enzyme inhibition activities.	Cestodes	no records found	[23, 75, 76]
Cissampelos mucronata A. Rich.	Hypoglycemic, antivenin, anti-diabetic, anti-ulcer, antispasmodic, anti-diarrhoeal and possess significant effects on male fertility.	no records found	Safe LD_{50} > 5000 mg/kg	[77–79]
Cissus quadrangularis L.	Bone healing, *anthelmintic, antiulcer, anti-inflammatory, anti-tumor, molluscicidal, gastro-protective, anti-osteoporotic, antioxidant and antimicrobial activities.	Earthworms: *Pheretima posthuma*	Safe LD_{50} - 3000 mg/kg	[80–83]
Cleridendrum ternatum Schinz	no records found	no records found	no records found	
Combretum heteroense Schinz *subsp. heteroense*	*Anthelmintic (antischistosomal), antifungal, anti-inflammatory and cytotoxicity activities.	Nematode: Worms of *C. elegans* var. Bristol Schistosomes: Worms of *S. haematobium*	no records found	[84–86]
Combretum imberbe Wawra	Antibacterial, anthelmintic, antioxidant, antifungal, *anthelmintic (antischistosomal), anti-hyperglycemic, anti-malarial, anti-snake and anti-inflammatory activities.	Nematode: Worms of *C. elegans* var. Bristol Schistosomes: Worms of *S. haematobium*	Highly toxic LC_{50}–168.6 μg/mL	[84–89]
Combretum zeyheri Sond	Antibacterial, anti-inflammatory, cytotoxicity against human cancer cell line, *anthelmintic (antischistosomal), antioxidant, antifungal and anti-proliferative activities.	Schistosomes: Worms of *S. haematobium*	Highly toxic LC_{50}–16 μg/ml to 159 μg/ml	[28, 60, 84, 85]
Crossopteryx febrifuga (G. Don) Benth.	Anti-inflammatory, *anthelmintic, anticonvulsant, analgesic, anti-plasmodial, antipyretic, antihyperglycemic, anti-proliferative and hypolipidemic activities.	Nematodes: *Haemonchus contortus*	Safe LD_{50}–5000 mg/kg	[55, 90–95]

Scientific name	Pharmacological properties	Biological target	Toxicological evaluation	Reference
Croton gratissimus Burch	Good antioxidant, anti-diabetic, anti-inflammatory, antibiotic, antiviral, analgesic, anticonvulsant, *anthelmintic (antiprotozoal and antileishmanial), anticancer, antiulcer, immunomodulatory, anti-pyretic, anti-plasmodial, hypolipidemic, antiarthritic, anti-eczemic, antihistimic and anti-coronary activities.	Protozoa: *T. b. rhodesiense* Leishmania: *Leishmania donovani*	Highly toxic LC_{50} Hexane fraction - 25.3 ± 0.87 μg/ml. DCM fraction - 67.3 ± 0.32 μg/ml.	[96–102]
Cynanchum viminale (L.) L. subsp. *viminale Sarcostemma viminale* (L) R. Br	Antipyretic, analgesic, and anti-inflammatory activities.	no records found	no records found	[103]
Dicoma anomala Sond.	*Anthelmintic, anticancer, antioxidant, antihyperglycemic, anti-inflammatory and antimicrobial activities.	Cestodes	Safe LC_{50} value of 3040 ± 1060 μg/ml	[34, 35, 104]
Diplorhynchus condylocarpon (Muell Arg.) Pich.	Sympatholytic, anti-amoebic, anti-plasmodial, analgesic, antibacterial, antimalarial, anti-inflammatory and antioxidant activities	no records found	Safe LD_{50} > 2000 mg/kg	[60, 105–107]
Elephantorrhiza goetzei (Harms)	*Anthelmintic, antifungal, antioxidant, antibacterial, antiviral, and cytotoxicity activities.	Cestodes Schistosomes	Moderately toxic LC_{50}_356.55 ± 24.55 μg/ml.	[23, 32]
Eriosema englerianum Harms.	Antimicrobial, antibacterial, antifungal and antioxidant activities.	no records found	no records found	[108, 109]
Erythrina abyssinica DC.	Antimycobacterial, antifungal, hypoglycemi, antiplasmodial, hepatoprotective, *antihelminthic and antimicrobial activities.	Nematodes: *Ascaridia galli*	Safe LC_{50}–5440 ± 0 μg/ml.	[104, 110–113]
Euclea divorum Hiern	Antimicrobial, diuretic cytotoxic, antibacterial, oxytocic, antifungal, diuretic, antioxidant, *antihelminthic and anti-plasmodial activities.	Nematodes: *Caenorhabditis elegans*	Safe LD_{50} - 2000 mg/kg	[114–117]

Scientific name	Pharmacological properties	Biological target	Toxicological evaluation	Reference
Euphorbia schinzii Pax	no records found	no records found	no records found	
Faurea saligna Harv	Antifungal activity.	no records found	no records found	[118]
Flacourtia indica (Burm.f) Merr	Antimicrobial, anti-diabetic, anthelmintic hepatoprotective, antiviral, *anthelmintic (antitrypanosomal and antileishmanial), anti-inflammatory, antimalarial, anti-plasmodial, antioxidant and anti-asthmatic activities.	Trypanosome: *Trypanosoma brucei brucei, Trypanosoma brucei rhodesiense, Trypanosoma cruzi* Leishmania: *Leishmania donovani*	Moderately toxic LC_{50}–467.31 ± 39.01 μg/ml	[19, 70, 119–123]
Gymnosporia senegalensis Loes *Maytenus senegalensis* (Lam) Exell	*Anthelmintic (antileishmanial), antioxidant, antiviral, antibacterial and antifungal activities.	Cestodes	Safe LC_{50}–2185.61 ± 872. 25 μg/ml LD_{50} > 1600 mg/kg	[19, 23, 70, 124–126]
Khaya anthotheca (Welw.) C. DC. *Khaya nyasica* Bak.f.	Antimicrobial, antioxidant, *anthelmintic (antitrypanosomal and antileishmanial), antiplatelet, antiviral and anti-plasmodial activities.	Trypanosome: Trypanosoma brucei rhodesiense and Trypanosoma cruzi Leishmania: Leishmania donovani	Moderately toxic LC50 - 482.19 ± 43.49 μg/ml.	[19, 70, 120, 131, 132]
Hydnora abyssinica A. Braun ex Schweinf. *Hydnora solmsiana* Dinter	Antibacterial, antioxidant, anti-diarrhoeal, antiglycation and antifungal activities.	no records found	Weak or low toxicity or mildly toxic LD_{50} > 1600 mg/kg	[127–130]
Kigellia africana (Lam.) Benth. *Kigelia pinnata* (Jacq.) DC.	Antiplasmodial, antiviral, antiulcer, anticancer, anti-diarrhoeal, antimicrobial, antioxidant, anti-diabetic, *anthelmintic (antitrypanosomal), effects on reproductive system and anti-inflammatory activities.	Trypanosomes: *Trypanosoma brucei* and *Trypanosoma bruceirhodesiense*	Safe LD_{50} > 5000 mg/kg	[70, 133–135]
Landolphia kirkii Dyer ex Hook. f.	no records found	no records found	no records found	
Lannea discolor (Sond.) Engl.	*Anthelmintic (nematicidal), antibacterial, antimycobacterial, antifungal, antioxidant and antiplasmodial activities.	Cestodes	Weak or low toxicity or mildly toxic LC_{50} values ranging 0.408 mg/mL to >1.0 mg/mL	[23, 34, 35, 136]

Scientific name	Pharmacological properties	Biological target	Toxicological evaluation	Reference
Lannea edulis (Sond.) Engl.	*Anthelmintic, anti-human immunodeficiency virus, antihyperglycemic, antihyperlipidemic, antimalarial, antimicrobial, antioxidant and cytotoxicity activities.	Cestodes	Safe LD_{50} > 6000 mg/kg	[23, 36, 104]
Lecaniodiscus fraxinifolias Bak.	*Anthelmintic activity.	Cestodes	no records found	[23]
Loranthus on *Dichrostachys cinerea*,	no records found	no records found	no records found	
Mondia whitei (Hook.f.) Skeels	Antidepressant, anti-diarrheal, antiepileptic, antibacterial, aphrodisiac, anti-convulsant, pro-erectile, antimicrobial, tyrosinase-inhibitory, anti-inflammatory, androgenic *anthelmintic, anti-tyrosinase, antioxidant, anticancer anti-spermatogenic and antifertility activities.	Schistosomes	Safe LD_{50} > 5000 mg/kg	[137–140]
Mucuna coriacea Baker subsp. irritans (Burtt Davy) Verdc.	no records found	no records found	no records found	
Musa sp.	Antioxidant, antibacterial, antiviral, anti-ulcerogenic, antithrombotic, anti-allergic, anti-inflammatory, antiallergenic, anti-diabetic, diuretic, mutagenecity, wound healing, antidiarrhoeal, *anthelmintic, antimalarial, anti-snake venom and vasodilatory activities.	Nematodes: *Haemonchus contortus* and *Trichostrongylus colubriformis*	Safe LD_{50} > 5000 mg/kg	[141–145]
Ozoroa reticulata (Baker f.) R. Fern. & A. Fern. *Ozoroa insignis* Del. subsp. *reticulata (*Bak. f.) Gillett *Heeria reticulata* Engl.	Antimicrobial, cytotoxic, antibacterial and *anthelmintic activities.	Cestodes Schistosomes	Highly toxic LC_{50} ranging 2.21–10.63 μg/ml	[23, 31, 146–149]
Peltophorum africanum Sond.	Antibacterial, antifungal, antiviral, antioxidant and *anthelmintic activities.	Schistosomes	Weak or low toxicity LC_{50} ranging 882–1060 ± 106 μg/ml	[23, 69, 104]

Scientific name	Pharmacological properties	Biological target	Toxicological evaluation	Reference
Phaseolus vulgaris L	Hypocholesterolemic, nephroprotective, anticancer, anti-hypertensive, diuretic, neuroprotective, antifertility, analgesic, antibacterial, hepatoprotective, antiobesity, osteoprotective, anti-inflammatory, antioxidant, antidiabetic, *anthelmintic, immunostimulatory, cardio-protective, litholytic, trypsin and α-amylase inhibitor activities.	Nematodes: *Trichostrongylus colubriformis* and *Teladorsagia circumcincta*	Safe LD_{50} up to 2000 mg/kg	[150–155]
Piliostigma thonningii (Schumach.) Milne-Redh.	*Anthelmintic (antileishmanial), anti-oxidative, antiviral, antipyretic, antibacterial and anti-inflammatory activities.	Cestodes Nematodes: *Haemonchus contortus*	Safe LD_{50} > 5000 mg/kg in rats.	[23, 55, 156–158]
Pogonarthria squarrosa (Licht.) Pilg.	no records found	no records found	no records found	
Pterocarpus angolensis DC.	*Anthelmintic, antibacterial, anti-plasmodial, anti-inflammatory and antifungal activities.	Cestodes	Weak or low toxicity or mildly toxic LC_{50} ranging 478–1320 ± 266 μg/ml.	[23, 104, 159–161]
Ricinus communis L	Anticonceptive, antioxidant, antidiabetic, antifertility, anti-inflammatory, antioxidant, *anthelmintic, hepatoprotective, insecticidal, wound-healing, anti-asthmatic, lipolytic, immunomodulatory and antimicrobial activities.	Nematodes	Safe LD_{50}–8000 mg/kg	[162–165]
Sansevieria hyacinthoides (L.) Druce	*Anthelmintic, antibacterial, antifungal and antioxidant activities.	Nematode: *Caenorhabditis elegans*	no records found	[31, 38, 114, 166–168]
Sclerocarya birrea (A. Rich.) Hochst. subsp. *caffra* (Sond.) Kokwaro	Anti-diarrhoeal, anti-diabetic, anti-inflammatory, anti-plasmodial, *anthelmintic, antimicrobial, antioxidant, antihypertensive, anti-convulsant and antinociceptive activities.	Nematode: *Haemonchus contortus*	Safe LC_{50}–1112.37 ± 210.04 μg/ml.	[19, 55, 70, 169]

Scientific name	Pharmacological properties	Biological target	Toxicological evaluation	Reference
Securidaca longipedunculata Fresen	Antibacterial, anti-plasmodial, *anthelmintic and antifungal activities.	Nematode: *Haemonchus contortus*	Moderately toxic LD_{50} value of 771 mg/kg	[55, 104, 159, 161, 170]
Senna italica Mill. subsp. *micrantha* (Brenan) Lock *Cassia italica* (Mill.) F.W. Andr.	Antibacterial, hypoglycemic effect anti-inflammatory, antipyretic, uteruscontractions, *anthelminthic, antioxidant, antiproliferative, analgesic, prostaglandin (PG) release, antineoplastic and antiviral activities.	Nematodes: *Haemonchus contortus*	Safe LD_{50} > 5000 mg/kg	[171–179]
Senna petersiana (Bolle) Lock *Cassia petersiana* Bolle	*Anthelmintic, antibacterial, antifungal, cyclooxygenase (COX) inhibitory, antiviral and antimicrobial activities.	Nematode: *Caenorhabditis elegans*	no records found	[180, 181]
Senna singueana (Delile) Lock *Cassia singueana* Del	*Anthelmintic, antioxidant, antiplasmodial, antiulcer, antipyretic, anti-inflammatory and analgesic activities.	Cestodes	Safe LD_{50}–2150 mg/kg	[23, 182, 183]
Solanum campylacanthum Solanum delegoense Dunal *S. incanum*	*Anthelmintic, antinociceptive effect, antipyretic, analgesic, antimicrobial, anti-inflammatory and anti-cytotoxic activities.	Cestodes	Safe LD_{50} > 2000 mg/kg	[23, 184–188]
Steganotaenia araliacea Hochst.	*Anthelmintic (antileishmanial and larvicidal), antimitotic, antitubulin, uterotonic, antioxidant, antibacterial, diuretic and antiplasmodial activities.	Cestodes	no records found	[23, 189–191]
Strychnos cocculoides Bak.	Antimalarial and antioxidant activities.	no records found	no records found	[31, 192, 193]
Termilia sericea Burch ex. DC	Antibacterial, antifungal, anti-neurodegenerative, anticancer, antioxidant, antiviral, anti-HIV, anti-fungal, antibacterial, anticancer, lipolytic, wound healing, *anthelmintic (antiprotozoal), anti-inflammatory and anti-oxidant activities.	Protozoa: *Trichomonas vaginalis*	Toxic LC_{50} < 300 μg/ml.	[19, 70, 194–200]
Terminalia brachystemma Welw.	*Anthelmintic, antifungal and antioxidant activities.	Cestodes	no records found	[23, 201, 202]

Scientific name	Pharmacological properties	Biological target	Toxicological evaluation	Reference
Toddalia asiatica (L.) Lam. *Toddalia aculeata* Pers.	Anti-inflammatory, anti-bacterial, anti-tumor, antifeedant analgesic, anti-HIV, anti-plasmodial, antiviral, *anthelmintic, analgesic, antiplatelet aggregation, wound healing, anticancer, spasmolytic activity and skin whitening activities.	Protozoa: *Ichthyophthirius multifiliis*	Weak or low toxicity or mildly toxic LD_{50} > 1000 mg/kg	[203–210]
Trichilia emetica Vahl subsp. *emetic Trichilia roka* Chiov.	*Anthelmintic (antischistosomal and antitrypanosomal), anti-diarrhoeal, antifungal, anti-oxidant, anti-infective, anti-inflammatory, antiviral, anticonvulsant, antifeedant, anti-plasmodial, antitussive, antimutagenic, bactericidal hepatoprotective and growth regulating activities.	Cestodes Schistosomes Trypanosomes: *Trypanosoma brucei brucei* and *Trypanosoma brucei rhodesiense*	Safe 2000 < LD_{50} < 5000 mg/kg	[23, 211–216]
Trichodesma ambacense Welw. subsp. hockii (De. Wild) Brummitt	no records found	no records found	no records found	
Vangueria infausta Burch. subsp. *infausta*	Antibacterial, antifungal, antimycobacterial, anti-inflammatory, antioxidant, *anthelmintic (antileishmanial), anti-plasmodial, antifeedant and prostaglandin synthesis inhibitory activities.	Leishmania: *Leishmania donovani*	Moderately toxic LC_{50} values ranging 338–416 ± 28.3 μg/mL	[39, 104, 105, 217–221]
Vernonia amydalina Del	Antimicrobial, antimalarial, antithrombotic, antioxidant, antipyretic, analgesic, anti-diabetic, laxative, hypoglycemic, anticancer, *antihelmintic, antifertility, anti-inflammatory, cathartic, antifungal and antibacterial activities.	Cestodes	Safe LD_{50}–5152.3 mg/kg. LD_{50}–3721 mg/kg.	[23, 222–224]
Vernonia philipsoniana Lawaltree	no records found	no records found	no records found	
Vigna unguiculata (L.) Walp.	Antioxidant, *anthelmintic, antibacterial, anti-diabetic, anti-depressant, anti-sickling, antifungal, antiviral, antimicrobial, antinociceptive, hypocholesterolemic, thrombolytic and hypolipidaemic activities.	Earthworms: *Edrilus euginiae*	Safe LD_{50} > 2000 mg/kg	[225–229]

Scientific name	Pharmacological properties	Biological target	Toxicological evaluation	Reference
Warburgia sulcata	no records found	no records found	no records found	
Ximenia caffra Sond.	*Anthelmintic, anti-amoebic, antibacterial, antigonococcal agent, antifungal, anti-inflammatory, antioxidant, anti-parasitic, anti-proliferative, insecticidal, HIV-1 reverse transcriptase (RT) inhibitory and non-mutagenic activities.	Cestodes	Highly Toxic LC_{50}–11.25 μg/ml	[23, 42, 146, 230–232]
Zanthoxylum chalybeum Engl.	Anti-plasmodial, antibacterial, *anthelmintic (antitrypanosomal), antifungal antiviral, anti-hyperglycemic, anti-hyperlidemic and anti-measles virus activities.	Nematodes: *Ascaris suum*	Safe LD_{50} > 5000 mg/kg	[233–238]
Ziziphus mucronata Willd	Antimicrobial, antiviral, anti-diabetic, anti-inflammatory, anti-oxidant, anti-plasmodial, *anthelmintic and anti-anemic activities.	Schistosomes Nematode: *Caenorhabditis elegans*	Safe LC_{50} > 1000 μg/ml LD_{50} > 5000 g/kg	[23, 239, 240]

In vitro *experiments were carried-out and reported by Mølgaard et al. [23] demonstrating dose-dependent anthelmintic activity. Anthelmintic activities reported were conducted on a number of biological targets (**Figure 6**): Cestodes; Earthworms:* Pheretima posthuma, Edrilus euginiae, Eisinia fetida*; Leishmania:* Leishmania donovani*; Nematode:* Ascaris suum, Ascaridia galli, Caenorhabditis elegans, Chabertia ovina, Cooperia spp., Haemonchus contortus, Trichostrongylus spp., Trichostrongylus colubriformis, Teladorsagia circumcincta, Teladorsagia spp; *Protozoa:* Ichthyophthirius multifiliis, Trichomonas vaginalis, T. b. rhodesiense*; Schistosomes:* Schistosoma haematobium*; Trypanosome:* Trypanosoma brucei brucei, Trypanosoma brucei rhodesiense, Trypanosoma cruzi. *More studies should be carried out on more prevalent biological targets such as Schistosomes:* Schistosoma haematobium.
** signifies the major pharmacological activity attributed by the different plant species of plants which is the anthelmintic activity.*

Table 2.
Pharmacological and toxicological evaluation of medicinal plants used to treat and manage bilharziasis and other parasitic infections in Zimbabwe.

Scientific name	Anthelmintic activity Lethal concentrations after 1 h
Abrus precatorius	[a]Cestodes: Stem 3.0 Root 1.2 mg/ml [a]Schistosomes: Stem 1.5 Root 0.6 mg/ml
Acacia karoo	[a]Cestodes: Leaves 3.1 mg/ml Root 17 mg/ml [c]Schistosomes: Leaves 103 mg/ml
AIbizia antunesiana	[a]Cestodes: Leaves and stem 16.8 mg/ml Root bark 6.3 [c]Schistosomes: Root bark 100 mg/ml
Cassia abbreviata	[a]Cestodes: Root and root bark 17.1 mg/ml
Celtis africana	[b]Cestodes: Leaves 63.0 mg/ml
Dicoma anomala	[a]Cestodes: Root 31.0 mg/ml

Scientific name	Anthelmintic activity Lethal concentrations after 1 h
Elephantorrhiza goetzei	[a]Cestodes: Stem bark 4.2 mg/ml fruits 12.1 mg/ml Root 17.4 Leaves and stem 15.9 mg/ml [a]Schistosomes: Stem bark 0.8 mg/ml
Gymnosporia senegalensis *Maytenus senegalensis*	[a]Cestodes: Leaves and stem 25.0 mg/ml Root 25.0 mg/ml Root bark 2.5 mg/ml [b]Schistosomes: Root bark 100 mg/ml
Lannea discolor	[b]Cestodes: Leaves and stem 10 mg/ml Root and root bark 12.9 mg/ml
Lannea edulis	[b]Cestodes: Leaves and stem 4.0 mg/ml
Lecaniodiscus fraxinifolias	[a]Cestodes: Leaves and stem 6.3 mg/ml Root 6.4 mg/ml
Ozoroa reticulata *Ozoroa insignis*	[a]Cestodes: Leaves 2.5 mg/ml Schistosomes: 34.0 mg/ml [a]Cestodes: Stem bark 51.0 mg/ml [a]Cestodes: Root bark 0.8 mg/ml [a]Schistosomes: Root bark 26.3 mg/ml Leaves + stem 25.3 mg/ml
Peltophorum africanum	[c]Schistosomes: Leaves and stem 100 mg/ml
Piliostigma thonningii	[a]Cestodes: Root and root bark 30.8 mg/ml
Pterocarpus angolensis	[a]Cestodes: Leaves 102.0 mg/ml Bark 51.3 mg/ml [c]Schistosomes: Leaves 102, stem 117 mg/ml
Senna singueana *Cassia singueana*	[a]Cestodes: Leaves ad stem 15.9 mg/ml Root bark 17.2 mg/ml
Solanum campylacanthum *Solanum delegoense*	[a]Cestodes: Leaves 50.2 mg/ml
Steganotaenia araliacea	[a]Cestodes; Leaves and stem 62.7 mg/ml
Terminalia brachystemma	[a]Cestodes: Leaves 13.4 mg/ml, Root 33.3 mg/ml, Fruit 1 66.5 mg/ml, Fruit 2 15.4 mg/ml
Trichilia emetica *Trichilia roka*	[b]Cestodes: Root and root bark 84.7 mg/ml [b]Schistosomes: Root 6.25 mg/ml [b]Trypanosomes: Leaves *Trypanosoma brucei brucei* - 14.9 mg/ml and *Trypanosoma brucei rhodesiense* - 8.6 mg/ml
Vernonia amydalina	[b]Cestodes: Root 1.7 mg/ml Root bark 59.5 mg/ml
Ziziphus mucronata	[c]Schistosomes: Root bark 101 mg/ml

[a]*All cestodes: schistosomules died.*
[b]*Some of the cestodes: schistosomules died.*
[c]*No cestodes: schistosomules died.*
Schistosomules of Schistosoma mansoni*, Cestodes of* Hymenolepis dimin.

Table 3.
Anthelmintic screening of Zimbabwean plants traditionally used against schistosomiasis [23].

3.3 Screening

Retrieved articles were first screened based on the titles and abstracts for relevance to the study excluding articles that reported on malaria and on veterinary use of medicinal plants. For example, we excluded articles on bovine mastitis and Oriental medicines, although they appeared in the search results. However, articles that

Toxicological profile	No of plants	Names of the plant species
Safe or nontoxic $LC_{50} \geq 1000$ μg/ml $2000 \leq LD_{50} \leq 5000$ mg/kg body weight	30	*Abrus precatorius, Asparagus spp, Burkea africanus, Carissa spinarum, Cassia abbreviata, Senna italica, Catunaregam swynnertonii, Cissampelos mucronata, Cissus quadrangularis, Crossopteryx febrifuga, Dicoma anomala, Diplorhynchus condylocarpon, Erythrina abyssinica, Euclea divorum, Gymnosporia senegalensis, Kigellia africana, Lannea edulis, Mondia whitei, Musa sp., Phaseolus vulgaris, Piliostigma thonningii, Ricinus communis, Sclerocarya birrea, Senna singueana, Solanum campylacanthum, Trichilia emetica, Vernonia amydalina, Vigna unguiculata, Zanthoxylum chalybeum and Ziziphus mucronata*
Weak or low toxicity or mildly toxic $500 \leq LC_{50} \leq 999$ μg/ml $1000 \leq LD_{50} \leq 2000$ mg/kg body weight	6	*Acacia karoo, Hydnora abyssinica, Lannea discolor, Peltophorum africanum, Pterocarpus angolensis and Toddalia asiatica*
Moderately toxic $250 \leq LC_{50} \leq 499$ μg/ml $300 \leq LD_{50} \leq 1000$ mg/kg body weight	5	*Elephantorrhiza goetzei, Flacourtia indica, Khaya anthotheca, Securidaca longipedunculata and Vangueria infausta*
Toxic $50 \leq LD_{50} \leq 300$ mg/kg body weight	1	*Termilia sericea*
Highly toxic $LC_{50} \leq 249$ μg/ml $0 \leq LD_{50} \leq 50$ mg/kg body weight	5	*Combretum imberbe, Combretum zeyheri, Croton gratissimus, Ozoroa reticulata and Ximenia caffra*
No records found	21	*AIbizia antunesiana, Celtis africana, Cleridendrum ternatum, Combretum heteroense, Cynanchum viminale, Eriosema englerianum, Euphorbia schinzii, Faurea saligna, Landolphia kirkii, Lecaniodiscus fraxinifolias, Loranthus on Dichrostachys cinerea, Mucuna coriacea, Pogonarthria squarrosa, Sansevieria hyacinthoides, Senna petersiana, Steganotaenia araliacea, Strychnos cocculoides, Terminalia brachystemma, Trichodesma ambacense, Vernonia philipsoniana and Warburgia sulcata*

Table 4.
Toxicological evaluation of medicinal plants used to treat and manage bilharziasis and other parasitic infections in Zimbabwe.

included both malaria and schistosomiasis were considered. The eligible full articles were then assessed further for inclusion in the study using the inclusion/exclusion criteria.

3.4 Inclusion and exclusion criteria

Full-text articles that at least reported on ethnobotany of Zimbabwean medicinal plants written in English and published in peer-reviewed journals, reports, books, theses and dissertations dated 31 December 2020 were considered. All publishing years were included without any geographical restrictions. Articles that reported data not relevant to the study or reviews or those not written in English were excluded from the study.

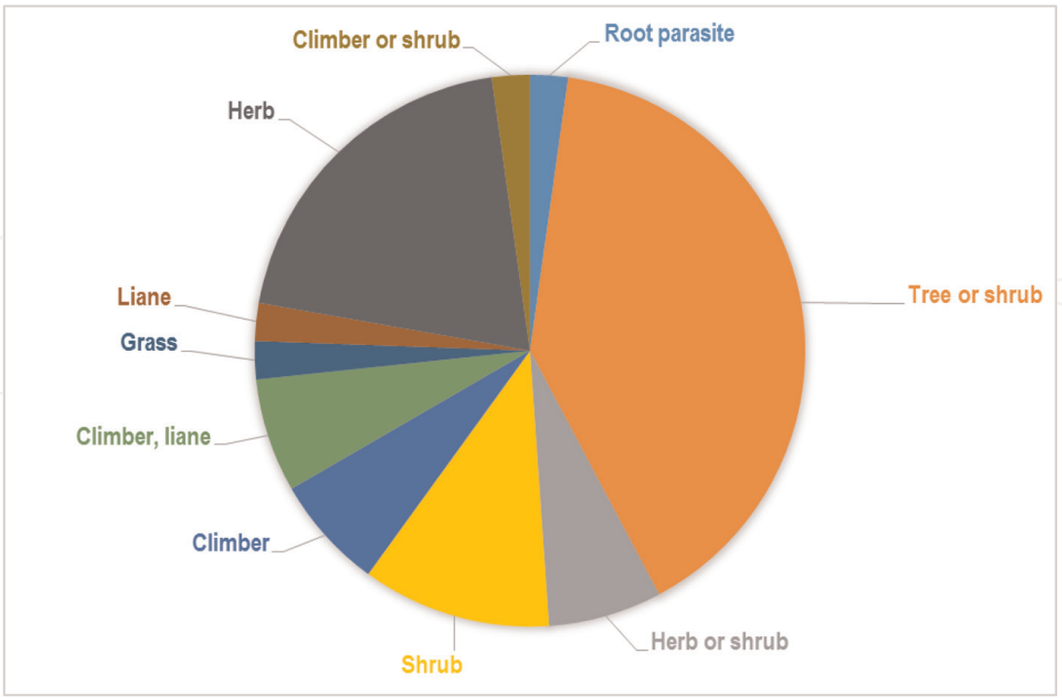

Figure 2.
Growth habit of medicinal plant species used to treat and manage bilharziasis and other parasitic infections in Zimbabwe.

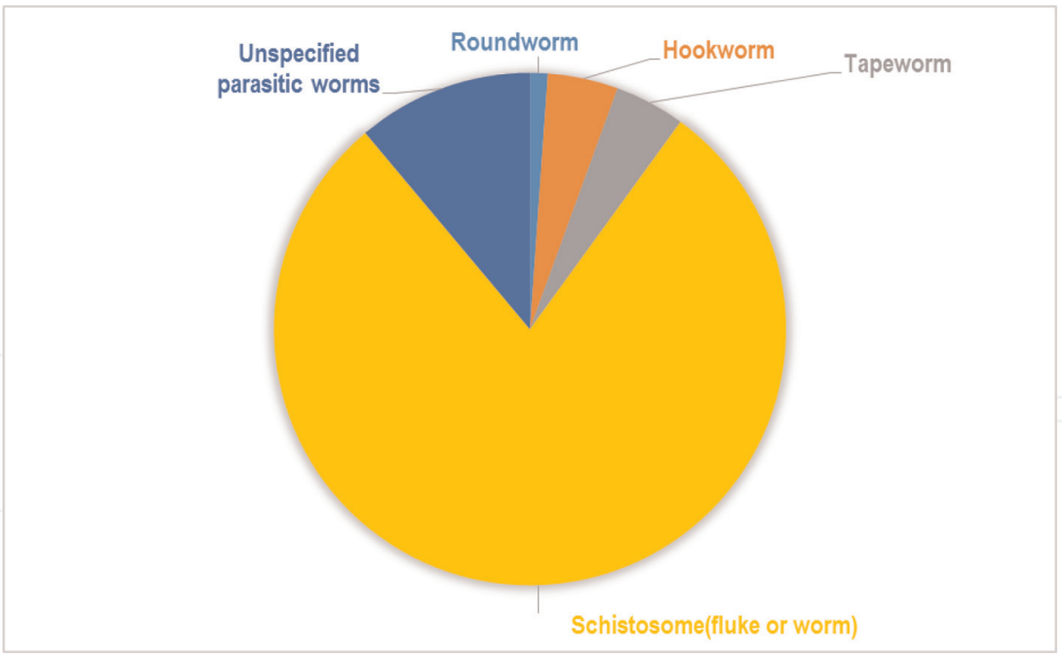

Figure 3.
Parasites managed or treated using medicinal plants in Zimbabwe.

3.5 Data extraction

A data collection tool was designed in Microsoft Excel (Microsoft Corporation, USA) to capture data on different aspects of Zimbabwean medicinal plants. Three reviewers independently extracted relevant data from the included articles regarding

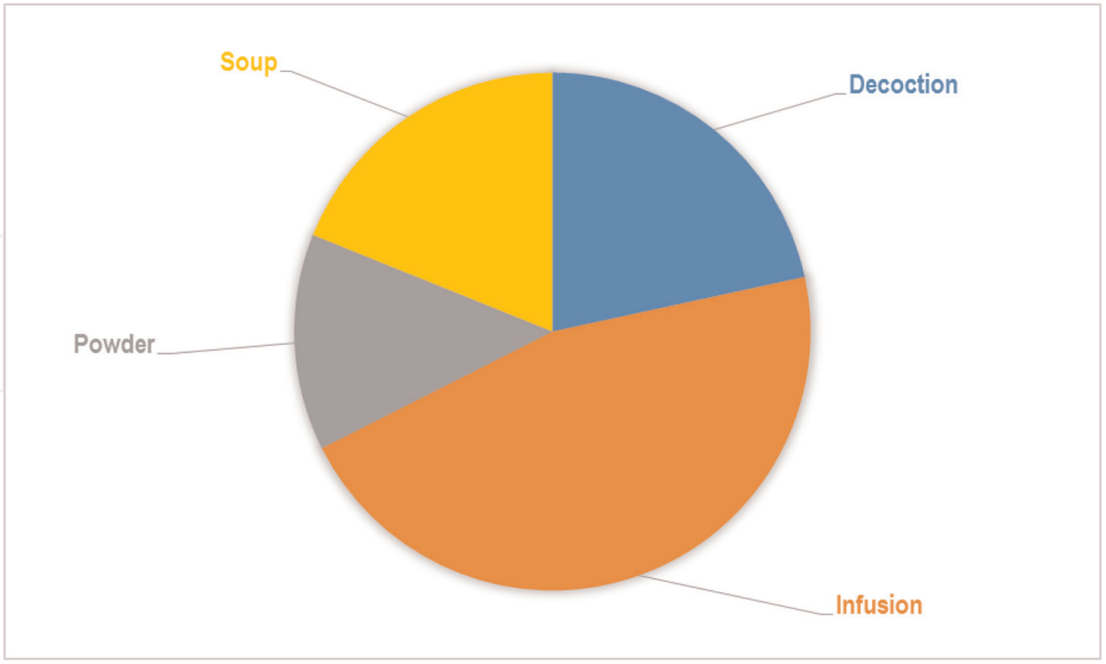

Figure 4.
Mode of preparation of medicinal plant species used to treat and manage bilharziasis and other parasitic infections in Zimbabwe.

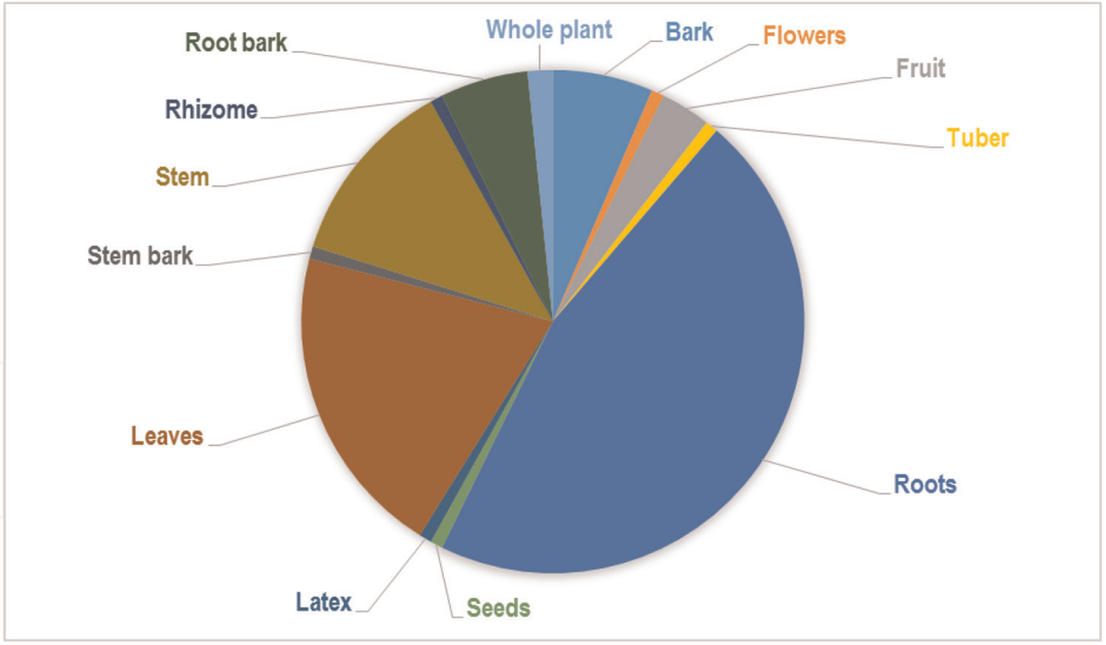

Figure 5.
Plant parts used for medicinal preparations used for the management of bilharziasis and other parasitic infections in Zimbabwe.

the ethnobotany of Zimbabwean medicinal plants. For ethnobotanical data, the diseases or ailments managed, parts used and mode of preparation and administration were captured. The collected data were checked for completeness and processed independently by two other reviewers.

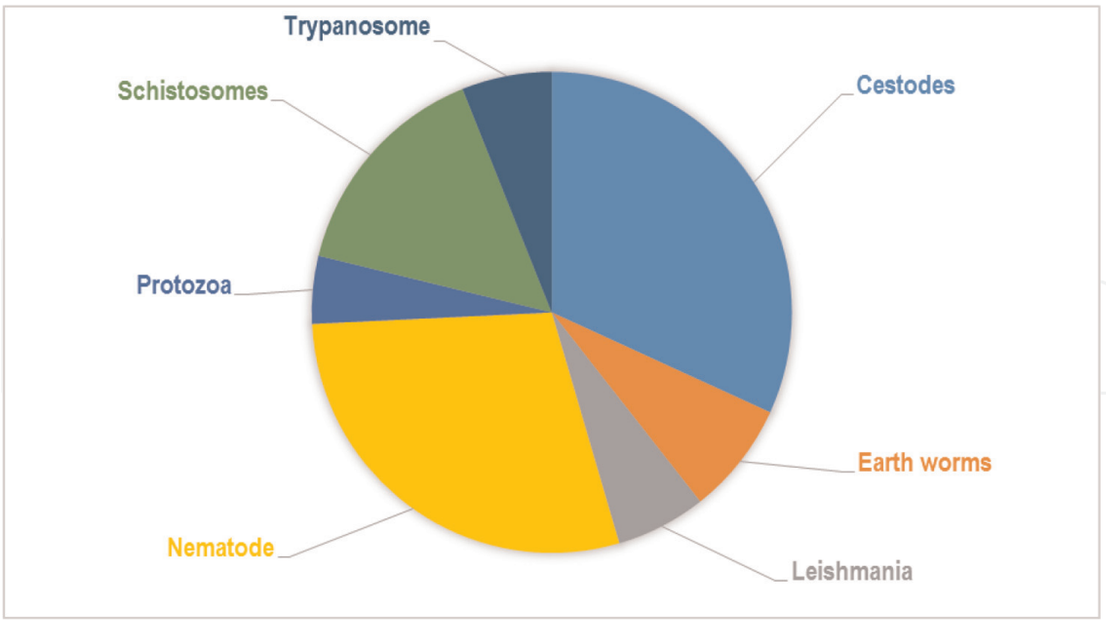

Figure 6.
Biological targets of tested parasites of medicinal plants reported.

4. Results and discussion

From the several scientific papers reviewed based on ethnobotanical surveys of different areas of Zimbabwe, the results are presented in the following sections.

4.1 Literature search and publications

A total of 750 reports were retrieved out of which 138 met the inclusion criteria and were reviewed. Most of the articles were published in the 2010–2019 decade, indicating a lot of research is being done as compared to the preceding decades. This could be due to: (1) the growing need for more effective and less toxic medicinal products of plant origin, (2) emerging antimicrobial resistance that has rendered most chemotherapeutic agents less effective, (3) new disease outbreaks like COVID-19 and (4) increase in noncommunicable diseases such as cancers, hypertension, diabetes mellitus and sexual dysfunction that require readily available, affordable, effective and safe therapies.

4.2 Ethnobotanical surveys and distribution of medicinal plants traditionally used to treat and manage bilharziasis and other parasitic infections in Zimbabwe

Based on soil, rainfall regime and several other factors, Zimbabwe is divided into 5 agro-ecological regions. A total of 43 of the medicinal plants reported in this review are widely distributed throughout the Northern (N), Eastern (E), Central (C), Western (W) and Southern (S) regions of Zimbabwe as represented in **Figure 7**. The remaining plant species were distributed in several regions across the country with n = 9 plant species distributed in 4 regions, n = 8 in 3 regions, n = 2 in 2 regions and n = 1 in 1 region. A total of n = 3 plant species are being cultivated [*Celtis africana*,

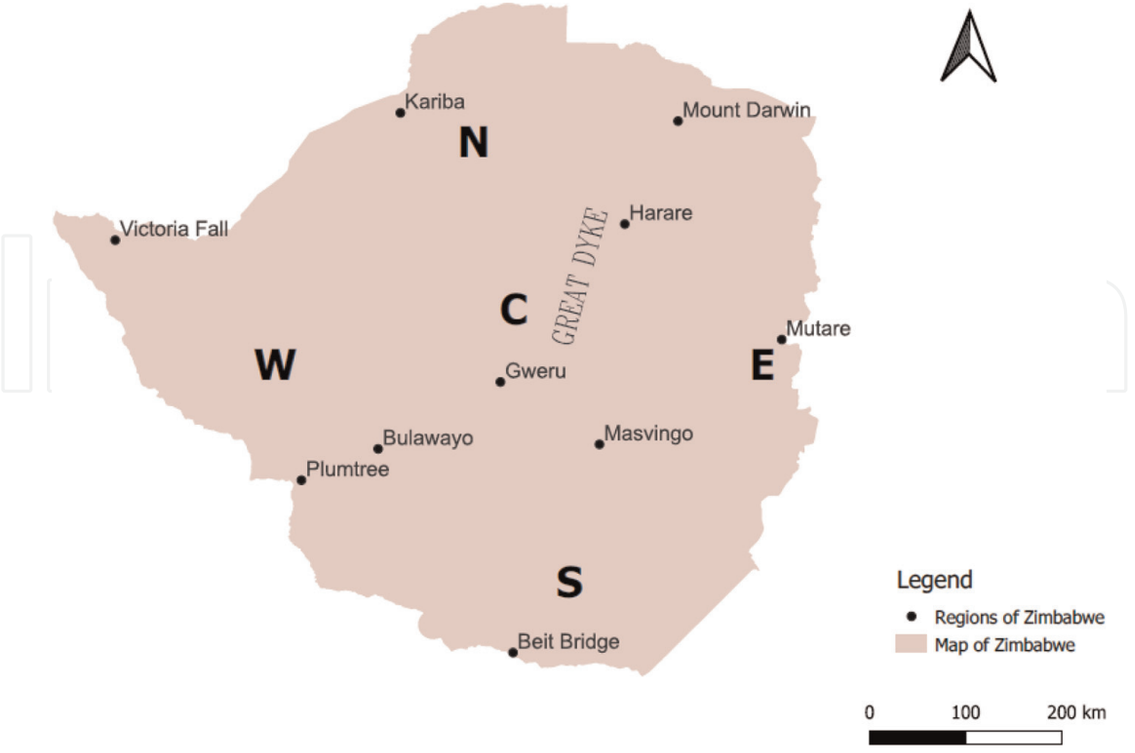

Figure 7.
General distribution of medicinal plants in different floristic regions of Zimbabwe.

Musa sp., Phaseolus vulgaris] and n = 1 has been recently introduced *Ricinus communis*. *Warburgia sulcata* had no information on distribution in Zimbabwe (**Table 1**).

The current review indicates that there are at least 68 species of plants belonging to 63 genera in 33 families used to treat and manage bilharziasis and other parasitic infections in Zimbabwe (**Table 1**).

Generally, the family with the highest number of medicinal plants in Zimbabwe was the *Fabaceae* family represented with a total of 17 plants followed by *Combretaceae* (n = 5), *Apocynaceae* (n = 5), *Anacardiaceae* (n = 4), *Rubiaceae* (n = 3), *Euphorbiaceae* (n = 3) *Asteraceae* (n = 3), *Rutaceae* (n = 2) and *Meliaceae* (n = 2). A further 24 more plant families which only had one plant represented were also recorded, giving a total of 33 families. These included *Apiaceae, Asparagaceae, Bignoniaceae, Boraginanceae, Canellaceae, Celastraceae, Dracaenaceae, Ebenaceae, Hydroraceae, Loganiaceae, Lorantaceae, Menispermaceae, Musaceae, Olacaceae, Poaceae, Polygalaceae, Proteaceae, Rhamnaceae, Salicaceae, Sapindaceae, Solanaceae, Ulmaceae, Verbenaceae* and *Vitaceae*.

Hutchings et al. [17] reported similar use of some medicinal plants reported in this study to treat and manage bilharziasis: *Abrus precatorius, Cassia abbreviata, Cissampelos mucronata, Euclea divorum, Faurea saligna, Gymnosporia senegalensis (Maytenus senegalensis), Mondia whitei, Pterocarpus angolensis, Sclerocarya birrea and Ximenia caffra*. Other studies reported similar anthelmintic medicinal plants; *Dicoma anomala* - Intestinal worms [15]; *Pterocarpus angolensis* - General use against intestinal worms, *Sclerocarya birrea* - Intestinal worms [18]; *Securidaca longipedunculata* – Tapeworm, *Vangueria infausta* - Roundworm [41]; *Ximenia caffra* - Intestinal worms [42]. These medicinal plants have been compiled by Cock et al. [10] review of Southern Africa.

4.3 Growth habit, parts used and mode of preparation of medicinal plants used to treat and manage bilharziasis and other parasitic infections in Zimbabwe

According to **Figure 2**, the frequency and type of plants used to treat and manage bilharziasis and other parasitic infections is as follows; tree (n = 23), tree, tree or shrub (n = 18), herb (n = 9), shrub (n = 5), climber, liane (n = 3), herb or shrub (n = 3), climber (n = 3), grass (n = 1), liane (n = 1), root parasite (n = 1) and shrub or climber (n = 1).

According to **Figure 3**, the parasites managed or treated are schistosomes (fluke or worm) 79%, unspecified parasitic worms 11%, hookworm 5%, tapeworm 4% and roundworm 1%. Midzi *et al.* [9] carried out a nationwide survey in Zimbabwe in 2010 and 2011 to map schistosomiasis and STH. The survey was conducted among primary school children. The study reported a high national prevalence of schistosomiasis (22.7%) and STH (5.5%). The common schistosome was *Schistosoma haematobium* with a prevalence of 18.0% while that of *Schistosoma mansoni* was 7.2%. The most common STH were hookworms (*Ascaris lumbricoides* and *Trichuris trichiura*) with a prevalence of 3.2% followed by *A. lumbricoides* and *T. trichiura* with prevalence of 2.5 and 0.1%, respectively [9]. Mutsaka-Makuvaza *et al*. [43] recorded a 13.3% prevalence in Madziwa, Shamva District among preschool-aged children. Therefore, there has been high use of medicinal plants to treat schistosomiasis due to its high prevalence in Zimbabwe.

The most frequently used mode of preparation was infusion 46% followed by decoction 22%, soup 19% and powder 13% (**Figure 4**). Methods of preparation of plant medicines seem to vary according to the area and subculture of the people in that region. Plant materials may be used as fresh or dry. However, the review observed a high usage of fresh material. Preparation of decoctions is carried out by boiling the plant material in water to such an extent that the volume of water is reduced to half. An infusion is a less concentrated version of a decoction and usually prepared by adding the plant material to water. There is a predominant use of decoctions and infusions which when both combined contribute to 68% of the gross mode of preparation. This may be attributed to the quick, low cost and easy to administer properties of these methods. Unfortunately, some of the ethomedicinal papers did not highlight the mode of preparation of the medicinal plants used [21, 22, 25, 26, 28].

The plant parts that are frequently used to treat and manage bilharziasis and other parasitic infections are shown in **Figure 5**. It appears the roots (46%) are the main target plant parts used. The use of the roots, bark and / or stem are the least environmentally sustainable part of the plant as its collection may lead to death of the plant however, they are the most preferred source of medicine. A number of papers did not highlight the plant parts used: [21, 22, 25, 26, 28].

4.4 Pharmacological properties of medicinal plants traditionally used to treat and manage bilharziasis and other parasitic infections in Zimbabwe

Some of the plant species have demonstrated a wide range of medicinal uses across different clinical conditions and therefore utilizing scientific methods to fully understand their pharmacological consequences could be vital. We have summarized the results of the pharmacological properties of 61 (89.7%) of the plant species (**Table 2**). The activities that were reported to be key in the treatment of bilharzia and parasitic infections were mainly dominated by the anthelmintic/antiparasitic properties. A

medicinal plant with anthelmintic activity is responsible for treating and managing infections caused by a broad range of parasites (trematodes, worms, cestodes and nematodes) [44] (**Table 3**). Other complementary pharmacological properties include antioxidant, antibacterial and antifungal activities responsible for managing and treating parasitic infections (**Table 2**).

4.5 Toxicological evaluation of medicinal plants used to treat and manage bilharziasis and other parasitic infections in Zimbabwe

Out of the medicinal plants listed in **Table 1**, a total of 47 species (69.1%) have been subjected to toxicological evaluation studies, while the remaining 21 species (30.9%) lacked documented studies in this regard (**Table 2**). According to Kumari and Kotecha [241] ensuring the safety of herbal medicines is crucial in herbal research due to the potential for adverse effects and interactions. Of the 47 plants with toxicological profiles, the toxicological activities of the extracts were evaluated in several ways, including their effects on liver chang cells, cytotoxic activities on human monocyte cells, genotoxicity and anticancer properties among others. According to Kumari and Kotecha [241] toxicity assessment of herbal medicines involves various techniques, including *in vivo, in vitro* and cell line studies, as well as modern methods like microarray analysis. The BSLT and rodent acute toxicity experiments were the most common methods used to assess the toxicity of the 47 plants with available toxicological profiles (**Table 2**). Munodawafa et al. [104] reported that the BSLT and rodent acute toxicity tests were the most common methods used to assess the toxicity of herbal extracts. This is probably because the tests are relatively reliable, accurate, simple and cost-effective.

Munodawafa et al. [104] and Erhabor et al. [242] classified BSLT toxicity by determining the lethal concentration [LC50] of medicinal plant extracts that resulted in 50% mortality in brine shrimps, and the lethal dose [LD50] causing 50% mortality in mice/rats for rodent acute toxicity studies. In the classification of BSLT toxicity, high toxicity was assigned to [LC50] values below 249 μg/mL, moderate toxicity encompassed the range of 250–499 μg/mL, concentrations between 500 and 999 μg/mL were regarded as weak or low in toxicity and values exceeding 1000 μg/mL were considered safe Bussmann et al. [243] and Erhabor et al. [242]. In the rodent acute toxicity tests conducted by Malebo et al. [125], substances with [LD50] values below 50 mg/kg body weight were classified as highly toxic, those within the range of 50–300 mg/kg body weight were considered toxic, 300–1000 mg/kg body weight fell under the category of moderately toxic, 1000–2000 mg/kg body weight were mildly toxic and 2000 up to 5000 mg/kg body weight were classified as non-toxic. Among the 47 plants used for the treatment and management of bilharziasis and other parasitic infections in Zimbabwe, 30 plants (63.8%) were deemed safe/non-toxic, 6 plants (12.8%) exhibited weak or low toxicity or mild toxicity, 5 plants (10.6%) showed moderate toxicity, 1 plant (2.1%) was classified as toxic and 5 plants (10.6%) were highly toxic (**Table 4**).

In vitro investigations play a crucial role in the initial screening of compounds; however, these studies do not yield insights regarding the bioavailability, toxicity and *in vivo* efficacy of the tested extract/compound. Consequently, it is imperative to conduct future *in vivo* studies utilizing appropriate animal models to comprehensively comprehend the pharmacokinetics and pharmacodynamics of the tested extract/compound. The majority of *in vivo* studies fail to provide evidence concerning the toxicity and mechanism of action of medicinal plants/compounds, thereby highlighting the

neglected nature of this aspect. Researchers are strongly encouraged to assess the toxicity levels and pharmacological actions of the tested plant/compound.

Conflict of interest

The authors declare no conflict of interest.

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