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Review on Schistosomiasis and Role of Ethnoveterinay Practice

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Abstract: Schistosomiasis is a parasitic disease transmitted by snail intermediate hosts. It is one of the most wide spread zoonotic disease which is endemic in many developing countries of the tropics and sub tropics causing considerable loss in humans and animals. The disease affects rural communities particularly those who depend upon irrigation to support their agriculture. Currently it affects between 200 and 300 million people in around 74 countries. The great majority (80-85%) of schistosomiasis is found in sub-Saharan Africa. Schistosomiasis is caused by trematode worms of the genus *Schistosoma* that live in the alimentary tract, bladder, as well as hepatic and nasal veins of humans and animals. Effective transmission of schistosomiasis occurs when the schistosome parasites, the aquatic snail hosts and the human or animal definitive hosts meet in space and time in surface water. The pathological changes with the disease are attributed by the adult parasite, cercaria and the eggs of the parasite. Health education, chemotherapy, environmental and biological control as well as provision of clean water have an innumerable role in the control activity of the disease. The use of traditional medicines in the treatment of schistosomiasis are economically important and a growing concern. There are various types of plants having antischistosomal and molluscicidal properties with minimal side effects used by developing countries and continuous to be used in the modern world. *Phytolacca dodecandra* (Endod) is the most widely studied molluscicide in Ethiopia.

Key words: Endod · Medicinal Plants · Molluscicide · Schistosomiasis

INTRODUCTION

Schistosomiasis is a parasitic disease transmitted by snail intermediate hosts. It is one of the most wide spread human and animal health problem in the tropics [1]. The disease is also known as bilharziasis after Theodor bilharz, who first identified the parasite in Cairo in 1851. The infection, is widespread with a relatively low mortality rate, but a high morbidity rate, causing severe debilitating illness in millions of people. Schistosomiasis is often associated with infested water contacts, such as dams and irrigation schemes, where the snail intermediate hosts of the parasites breed in WHO [2]. It is the second most prevalent tropical disease in Africa after malaria and is of great public health and socio-economic importance in the developing world. Currently it affects between 200 and 300 million people with in 74 countries [3].

Schistosomiasis is caused by trematode worms of the genus *Schistosoma* that live in the alimentary tract and bladder of humans and animals but *Schistosoma nasale* is found in the nasal vein. The most common species of *Schistosoma* infecting mammals and causing Schistosomiasis are *Schistosoma hematobium*, which affects 54 countries in Africa and the Eastern Mediterranean and causes urinary schistosomiasis, *Schistosoma. mansoni*, *Schistosoma. japonicum, Schistosoma intercalatum, Schistosoma mattheei, Schistosoma bovis* and *Schistosoma nasalis* [4, 5].

As the disease is transmitted by snail vector the transmission outcome is governed by the infection rates among snails, degree of contact with water and social and cultural habits of the population in areas where Schistosomiasis is endemic. *Schistosoma* and its intermediate host the snail are integral parts of the freshwater aquatic environments in which they are found. *Biomphalaria* and *Bulinusare* the two primary genera of snails capable of harboring infections with *S. mansoni* and *S. hematobium* [6]. As Urquhart *et al*. [7] discussed the blood fluke reside in the mesenteric and vesicle venules producing large number of eggs daily that remain

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in the host tissue, in which they are situated in by inducing immunological mediated granulomatous inflammation and fibrosis. As a result heavy worm burdens may produce hepatosplenic disease in *S. mansoni* and *S. japonica* and urinary tract disease in *S. hematobium*. Since both the schistosomes and the eggs utilize host metabolites and because the host responses to the parasite are affected by its nutritional status, malnutrition strongly affects both the parasite and the complex host-parasite relationship [8]. The body defends the infection by developing fever coinciding with larval maturation, migration and oviposition as in the case of acute Schistosomiasis. When the infection is well established, the parasite comes under oxidative stress generated by the host immune system which is counteracted by the parasite antioxidant defense mechanism [9].

Patient therapy is heavily dependent on chemotherapy with Praziquantel as the World Health Organization-recommended drug, but drug resistance and possible reoccurrence of infection encouraged the search for new drug possibly from natural resources, application of ethno veterinary practices and traditional approaches to treat and control the disease [10].

Therefore the objectives of this seminar paper are:

- To overview the control strategies of Schistosomiasis.
- To indicate the role of medicinal plants as an alternative means for Schistosomiasis control.

Schistosomiasis: Schistosomiasis is caused by trematodes of the family schistomatidae, genera *Schistosoma* and *Orientobilharzia*. Schistosomes are dioecious parasitic flatworms, which live in the vasculature of their mammalian definitive hosts. They are the causative agent of schistosomiasis, a disease of considerable medical and veterinary importance in tropical and subtropical regions [11]. Schistosomiasis is a chronic debilitating Infection affecting both humans and animals by different species of schistosomes. Other names given to schistosomiasis are blood fluke, snail fever and also Bilharziasis [12].

Etiology: Taxonomically the fluke that cause schistosomiasis belong to the Phylum: Platy helminthes; Class: Trematoda; Subclass: Digenea; Family: Schistosomatidae; and Genus: Schistosoma. There are many species under the genus *Schistosoma*. However, the most important species both in human and veterinary field that causes pathological changes in their associated organs or predilection sites are *S. nasale, S. bovis S. indicum, S. spindale, S. hematobium, S. intercalatum S. japonicum* and *S. mattheei* [13].

Morphology: Adult schistosomes have a basic bilateral symmetry, oral and ventral suckers, a body covering of a syncytial tegument, a blind-ending digestive system consisting of mouth, esophagus and bifurcated tail. Schistosomes exhibit sexual dimorphism and have distinct separate sexes. Adult worms are about 0.3-3 cm in length that lives in the blood vessels around the intestine hepatic, nasal or bladder veins. The mature male worm is broad and flat, inwardly curved forming a groove called gynaecophoric canal to clap the female which is longer than the male [14]. The female worm after copulation is set free to lay its eggs. Each mature female produces about two hundred ova per day. The eggs are spindle shaped having lateral or terminal spine depending on the type of species [15].

Lifecycle: For the completion of the life cycle of *Schistosoma* species both the different genera's of intermediate host, the snail and the final hosts including man and mammals are involved in the aquatic environment. Adult *Schistosoma* species living in blood stream release their eggs and passes out from the final host through feces, nasal discharge or urine [16]. Once the egg gets contact with water free swimming meracida emerge from the egg and penetrate the soft tissues of the snail. Within the snail, meracida immediately differentiate into cercaia via a so-called mother-sporocyst and daughter-sporocyst generation. A few thousands of cercaria results from a single miracidium every one of which is capable of infecting man. The cercariae propel themselves in water with the aid of their bifurcated tail and actively seek out their final host. When they recognize human skin, they penetrate it within a very short time or taken by other mammals through drinking or eating [17]. Following migration through the body within the bloodstream, if they meet a partner of the opposite sex, they develop into sexually mature adults, laying eggs and complete its life cycle as shown Fig. 1 [18].

Pathogenesis: Schistosomiasis is more serious and important infection in sheep than in larger ruminants and in cattle high prevalence of the disease is detected even where there is a rare clinical sign. The pathogenic changes with schistosomiasis are attributed by the adult parasite, cercaria and the eggs of the parasite [4]. Acute disease is characterized by diarrhea and anorexia which

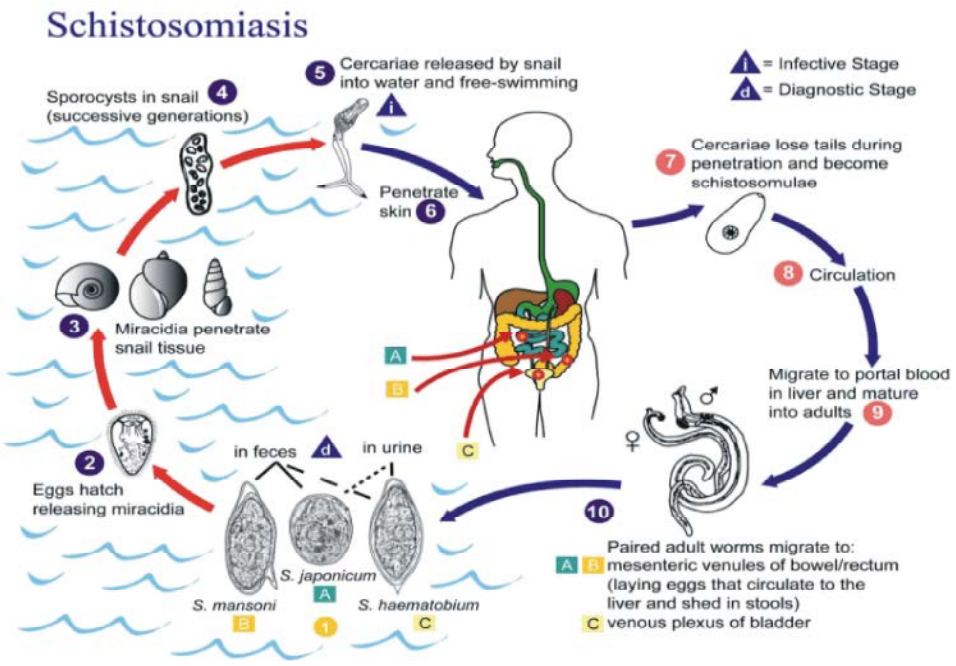

Fig. 1: General life cycle of *Schistosoma* species
Source: CDC [19]

occurs 7-8 weeks after heavy infection and is due to the inflammatory and granulomatous response to the deposition of eggs in the mesenteric veins and their subsequent infiltration into the intestinal mucosa. Following massive infection death can occur rapidly, but more usually the clinical signs abate slowly as the infection progresses. As this occurs, there is a partial shift of worms away from the intestinal mucosa and reactions to these migrating parasites and their eggs can occur in the liver [7].

At necropsy during the acute phase of the disease there are marked hemorrhagic lesions in the mucosa of the intestine, but as the disease progresses the wall of the intestine appears grayish, thickened and edematous due to the migratory effects of the egg and the associated inflammatory changes. The liver on sectioning shows egg granuloma and portal fibrosis. Hepatic fibrosis due to granulomatous inflammation elicited by a cell mediated hypersensitivity to parasitic egg antigen that logged in hepatic tissue is the main cause of mortality and morbidity in human Schistosomiasis [17].

Clinical Signs: The clinical sign varies depending on the stages of the disease. Early signs of urinary Schistosomiasis caused by *S. hematobium* are hematuria, shrinking, kidney damage and dysuria, while its long-term effects include renal failure and bladder carcinoma. Intestinal Schistosomiasis (caused by *S. mansoni*, *S. japonicum*, *S. intercalatum* and *S. mekongi*) gives rise to bloody diarrhea and abdominal pain and finally stunted growth and anemia can be outcomes of the infection [13]. Skin eruption and cercarial dermatitis are produced at the site of entry. Granulomas are also developed in the nose as a result of *S. nasale* infection. The disease significantly affects the quality of life, but death rate is relatively low [17].

Epidemiology: Schistosomiasis or snail fever is most commonly found in areas with water, being dependent upon water as a medium for infection of both the intermediate and final host. Water with slightly acidic ph is required for hatching of the egg. High rain fall is good predisposing factor for the occurrence of the parasite [13]. Particularly it is common in tropical and subtropical countries like Africa, Caribbean, eastern South America, East Asia and in the Middle East. The disease affects between 200 and 300 million people in around 74 countries. Over 600 million people are reported to be at risk of this trematode disease [3].

The great majority (80-85%) of schistosomiasis is found in sub-Saharan Africa, due to low socioeconomy or favorable climate for breeding of the snail and transmission of the disease [20]. In Ethiopia, various epidemiological studies conducted on cattle

schistosomiasis were indicative of the epidemicity of the disease in large stagnant water bodies and marshy free grazing areas. The prevalence of *S. bovis* has reported from different regions of the country by fecal examination [21]. About 29.89 million people are at risk of acquiring schistosomiasis and of these 4 million are infected. The incidence in Ethiopia is increased by construction of dams and expansion of irrigation based agriculture schemes and population movements. Transmission of schistosomiasis will occur when the schistosome parasites, the aquatic snail hosts and the human or animal definitive hosts meet in space and time in surface water [22].

The intermediate hosts having veterinary and public health importance belong to the genus *Biomphalaria*, *Bulinus*, Oncomelania*, Indoplanorbis*, *Planorbis* and *Radix* and within these genera there are about 350 species. Most of these snails are aquatic that live under the water and cannot usually survive elsewhere. But there are also amphibious snails adapted for living in and out of water (*Oncomelania*). A large population of snails inhabits freshwaters, where the larvae of parasitic trematodes also pass part of their life [23]. Snail of the genus *Biomphalaria* serve as intermediate hosts of *S. mansoni*in Africa and America and *Bulinus* serve as the intermediate hosts of *S. haematobium* in Africa and the Eastern Mediterranean. In south-east Asia the genera *Oncomelania* and *Tricula* serve as the intermediate hosts of *S. japonicum* and *S. mekongi,* respectively. Cattle, sheep, goat zebra, horse, pig, dog, donkey man, birds and other wild animals are affected by the disease as indicated by Table 1 [14].

Diagnosis: Diagnosis of schistosomiasis is based on clinical signs and symptoms, history of living in an endemic or marshy area, serological tests for anti-bodies and parasite antigens, finding the characteristic eggs and meracida recovery through culturing [24]. In areas endemic for Schistosoma, detection of spindle shaped eggs having lateral or terminal spine depending on the type of species of the parasites in the feces and urine is the gold standard technique of Schistosomiasis diagnosis [17].

For people from non-endemic areas or living in low transmission areas, serological and immunological tests may be useful in showing exposure to infection and the need for thorough examination and treatment. Urogenital Schistosomiasis can be diagnosed by filtration of urine followed by microscopic examination to detect *S. hematobium* eggs [24]. Serologic tests (e.g. Circumoval Precipitin test [COPT] and Indirect Hemaglutination Assay [IHA]) are improved tests for the detection of the presence of antibody against different *Schistosoma* stages. Although these tests were found to be more sensitive, acute infection cannot be distinguished from chronic infection [14].

Molecular Diagnosis: The detection of specific DNA sequences by polymerase chain reaction (PCR) has proved extremely valuable for the analysis of genetic disorders and the diagnosis of a variety of infectious disease pathogens (24). Polymerase chain reaction (PCR)-based methods have shown high sensitivity and specificity for the detection of parasitic DNA and have been used for the detection of a broad range of parasites (14) Until now their use in human epidemiological surveys has been limited with more studies exploring the potential of schistosome-specific PCR focusing more on the snail vector rather than its definitive host.10, 11 Recent developments in the simplification of DNA isolation procedures and PCR technology, especially real-time PCR, have made DNA amplification a worthwhile alternative for microscopy-based diagnostic methods (17).

Table 1: Some common Schistosoma species, hosts and their distribution in the world.

No	Species	Host	Distribution	Intermediate host
1.	*S. bovis*	Ruminants	Africa, middle east, Asia, Southern Europe.	*Bulinus* spp
2.	*S. mattheei*	Ruminants and occasionally man	Africa	*Bulinus africanus*,
3.	*S. japonicum*	Man and domestic animals	Far east, east Asia(China, Indonesia and Philippines)	*Oncomelania* spp
4.	*S. leiperi*	Cattle	Africa	*Bulinus africanus*
5.	*S. spindale*	Ruminants, horse and pig	Asia and Far east	*Indoplanorbis exustus*
6.	*S. incognitum*	Pigs and dogs	India and Pakistan	*Radix luteola*
7.	*S. monsoni*	Man and wild animals	Africa, South America and middle east	*Biomphalaria* species
8.	*S. turkestanica*	Ruminants	Africa	*Radix. aurcularia*
9.	*S. nasale*	Ruminants and horse	India and Pakistan	*Indoplanorbis exustus*
10.	*S. hematobium*	Humans	Africa, middle east	*Biomphalaria* species

Source: Lefevre *et al*. [14]

Control and Treatment: The disease can be controlled by working against the intermediate host or through actual pathogenic agent. Preventive chemotherapy, vector control, access to safe drinking-water, basic sanitation, hygiene services and health education are public health interventions in the control of Schistosomiasis. WHO also has proposed a plan for the control and elimination of Schistosomiasis and states that elimination may be possible through the main control interventions and improved coordination of stakeholders [25]. Of the above-mentioned interventions, preventive chemotherapy with Praziquantel has been selected as the most important tool as it has rapid impact than snail control which may harm the environment and costs more [26].

Control Through Main Host: *Chemotherapy*: Treatment of infected cases provides the most effective short-term results and it also reduces morbidity and rate of the transmission [27]. Currently chemotherapeutic treatment of Schistosomiasis mainly relies on metrifonateoxamniquine and Praziquantel [28]. Metrifonate is derived from oregano-phosphorus insecticides and is responsible for paralysis of the worm by inhibiting the acetyl cholinesterase enzyme. Under high concentration it is toxic to human cell by diminishing erythrocytic cholinesterase activity and its low concentration causes recovery of the worm. Oxamniquine is a substrate for sulfotransferase that produces an ester which is able to react with nucleic acids and there by interferes with replication and transcription process. This drug causes tegument damage and increased motility. Oxamniquine has low side effects to humans but the emergency of resistance strains combined with high production cost and its restricted use for *S. monsoni* make the drug un usable for control [29]. Praziquantel: It is WHO recommended drug which has been used for the treatment of Schistosomiasis for the last 20 years. The drug causes paralysis and tegument damage to allow the host immune system to penetrate the interior of the parasite and eliminate it [2]. The emergency of resistance and diminished efficacy forces to search for new compounds from natural products mainly plants with schistosomocidal activity [30].

Health Education: Creating awareness to those exposed groups of individuals like school children under seventeen years old, water development and irrigation workers and farmers about the transmission, control strategy and severity of the disease are important parameters to tackle the disease progression in its endemic areas [31].

Vaccination: Vaccine, ultimately, is anticipated to be the most effective form of Schistosomiasis treatment and control [32]. If the vaccine is proved to be effective and inexpensive enough for worldwide distribution, it would eliminate the need for snail and reservoir host control. However, there is no vaccine yet available, but there is a 3rd phase efficacy trial in Senegal using Sm28GST antigen to prevent reinfection among infected and treated children. Other candidate vaccine antigens exist and have been tested in animal models while new ones are being identified through genome studies [5].

Control Through the Intermediate Host: *Biological control*: Biological associations that exist naturally between the snail and other organism such as microsporidium species, *Trematocranus Placodon* and *Tilapia* fish interfere with the development of the sporocyst by competing for space, feed and by eating them. Therefore, more emphasis should be put on searching for these organisms for controlling the intermediate host [33].

Environmental Control: Schistosomiasis is transmitted by water contacts during watering, bathing, irrigation and other farming activities in snail contaminated water. Therefore, keeping hygienic status of the working area, providing safe drinking water, sanitary facilities, washing, cattle watering and bathing facilities reduce the risk of infection with Schistosomiasis [29].

Using Molluscicides: Molluscicides like copper sulfate and, copper carbonate kill the snail in the living area there by disrupting the life cycle of *Schistosoma* by preventing the development of meracida in to cercariae. Newer molluscicides such as nicotinanilide, organotindibromo-nitroazobenzene, pentachlorophenate, sodiumdichloro-bromophenol, niclosamide and acetamide are also used for snail control [34]. Plant molluscicides such as Endod (Phytolacca dodecandra) are also found to be effective to control the snail in its habitat. The active components found in endod which are capable of killing snails are Saponin or lemma toxins [35].

Ethnoveterinary Practices for the Control of Schitosomiasis

Ethnoveterinay Practices: The application of traditional medicines to veterinary medicine has been termed as ethno veterinary medicine. The term 'ethno veterinary' is the result of efforts made by Dr. Constance M. McCorkle. It was first used in her article, entitled "An introduction to ethnoveterinary research and development" [36]. It has

been defined as an indigenous animal health care system that includes the traditional beliefs, knowledge, skills, methods and practices of a given society [37]. The knowledge varies from region to region and from community to community. Like scientific veterinary medicine, ethno veterinary practices (EVP) have been developed by trial and error and by deliberate experimentation. But ethno veterinary medicine is developed by farmers in fields and barns, rather than by scientists in laboratories and clinics. It is less systematic and less formalized and is usually transferred from generation to generation by word of mouth rather than in writing [38].

Ethno veterinary medicine comprises of traditional surgical techniques such as bone setting, traditional immunization, management, cultural attitudes, spirituals, husbandry operations, magicoreligious practices and the use of herbal medicines to treat and prevent livestock diseases. Of the traditional practices in our country Ethiopia drenching of healthy animals with diarrheic feces taken from sick animals diluted in water was used to control rinderpest outbreak. As a means of preventing contagious bovine pleuropneumonia, Boran pastoralists cut the skin of healthy cattle on the face above the nostrils and replace it with a piece of lung tissue taken from an animal which has died from the disease and these all serve as a crude forms of vaccination [39].

At the other extreme, spiritual practice is also widely used in Ethiopian traditional veterinary medicine. Amulets are tied round the horns to avoid 'evil eyes'. For many diseases, prohibition of drinking water for a sick animal is common, especially after a local treatment; this is probably intended to prevent the spread of contagious diseases [39]. Alternative medicine through effective and safe medicinal plants with oral administration is practiced by most developing countries having limited resources. Although numerous medicinal plants are used by resource-limited farmers to treat diseases of livestock; only a few plants having acarcidal properties have been documented. This is so because, most research on EVP has been limited to finding out which plants are used for which purpose [40].

Medicinal Plants Against Schistosomiasis: The use of medicinal plants is becoming more important in developing countries as it is easily accessible, easy to prepare and administer, less costly or nothing at all, environmental friendly and part of one's own culture. Another factor that makes peoples to use traditional medicine is that unavailability of conventional medicine, scarcity of veterinary services, resistance due to indiscriminate use of the same drug and expensiveness of drugs [41]. Many of the traditionally used medicinal plants contain pharmacologically active compounds and are used in the preparation of both traditional and modern medicines. The most important of these substances are oils, fatty oils, glycosides, resin, gums, mucilage, tannins, alkaloids and steroids [42]. Plants are known to offer excellent perspective for the discovery of new therapeutic products whose subsequent development may lead to discovery of safe and therapeutically effective drugs [43]. The plants act either on the Schistosoma itself or on the intermediate host and they are called antischistosomal and molluscicidal respectively [44].

Antischistosomal Plants: Many treatment and control activities depend on Praziquantel for treating patients with Schistosomiasis and other fluke infections. However, loss of Praziquantel efficacy, its inaccessibility, drug resistance and high cost requiring hard currency greatly challenges Schistosomiasis control efforts. Therefore, there is a need to screen local plants as other alternative source of Schistosoma chemotherapeutic agents and is witnessed by the use of medicinal plants in developing countries [45]. Generally plant extracts are responsible for host immune modulation, morphological or tegument alteration, mating disruption, reduction in the reproduction fitness of male and female and paralysis of the worm by interfering its nervous system function as indicated in table 2 below [28].

Extracts That Disrupt Mating: Mating is a fundamental process of the parasite viability inside the host and to establish infection .Egg production and maturation occurs only when the female is held in a groove within the male body called the gynecophoric canal [15]. But oils from *Plectranthus neochilus*, extracts from *calyptridiumumbellatum* and other compounds like artemeter, curcumin, vernodalin, piplartin and artesunate induces separation of male and female and stops the release of eggs which is relevant in the pathology and transmission of disease [28].

Extracts Acting on the Tegument Structure: The tegument of Schistosoma is involved in absorption, secretion and acts as a physical barrier against components of the humoral and cellular host immune system Tegument alteration impairs the absorption

Table 2: Medicinal plants used in the treatment of schistosomiasis with their names, action and part used:

No	Name of plant	Compound	Part used	Action
1.	*Curcuma longa* (Zingiberaceae)	Curcumin	Dried rhizome, -tuber	Reduction in the oviposition, reduction in the motor activity.
2.	*Alium sativum* (Amaryllidaceae)	Aqueous extract, Dry crude extract	Crashed leaves	Tegument alteration
3.	*Clerodendrum umbellatum*	Aqueous extract	Leaves	Reduction in the oviposition.
4.	*Commiphora molmol*	Myrrh	Stem	Immunomodulation, collapse of tubercle
5.	*Dryopteris* spp.	Phloroglucinol	Rhizome	Inhibition of motor activity, tegument alteration.
6.	*Zingiber officinale* (Ginger)	Aqueous extract	Rhizome	Ant-inflammatory, antioxidant
7.	*Ageratum* (Burseraceae)	Essential oil	Leaves	Separation of male and female.
8.	Baccharis dracunculifolia	Essential oil	Leaves	Tegument alteration.
9.	*Nigella sativa* (Ranunculaceae)	Oil, Aqueous, Ethanolic and chloroform extract	Seeds	Immunomodulation, antioxidant
10.	Piper tuberculatum	Inflorescence	Leaves	Reduction in the motor activity
11.	*Vernonia amygdalina*	Vernodalin	Leaves	Inhibition of motor activity, tegument alteration.
12.	*Artemisia annua* (Asteraceae)	Artemether	Leaves	Tegument disruption alteration of the reproductive organ.

Source: Silmara *et al*. [49].

function or glucose uptake and causes profound effect on worm's metabolism. Due to this fact plant extracts affecting the tegument structure make the parasite more sensitive to the host immune response and makes a relevant target for drug discovery [6].

Plant Extracts Acting on the Parasite Neuro-Muscular System: The nervous system of schistosomiasis has been considered as relevant target for drug discovery. Plants *vernonia amygdalina*, *Artemisia annua* and *scheffler avinosa* causes observable changes such as paralysis in Schistosoma as a result of their interference with neuromodulator and neurotransmitters like serotonin, dopamine, acetyl-choline, epinephrine, glutamate and a variety of neuro-peptides [46].

Medicinal Plants Having Anti-Inflammatory Effect: The granuloma formation in Schistosoma infection is due to the maturation, migration and deposition of the eggs in the mesenteric vein and bladder. Medicinal plants such as *Commiphora mukul* with ethyl-acetate and lead compound have an inhibitory effect on mitogenic lymphocyte proliferation of the peripheral mono nuclear cells, inflammatory mediators such as INF-gamma, IL-12, TNF-alpha and IL-1beta to reduce inflammation and granuloma formation [47]. Antischistosomal effect of either garlic or onion is also due to their effect on the host immune response [48]. They contain an immunomodulator fraction or a sulphuric compound which affect the course of infection and shift the cytokine pattern from THC2-lymphocytes mediated immune response, responsible for granuloma formation, to THC1-lymphocytes - mediated immune responses, responsible for immune resistance [48].

Molluscicidal Plants: Many plant species have been used throughout the world in traditional medicine for the treatment of both veterinary and human helminthes infections and evaluated for their Molluscicidal activity against snail intermediate hosts. Factor like high cost of imported synthetic compounds, the negative impacts of synthetic molluscicides on the environment and increasing snail resistance initiates individuals to search for Molluscicidal plants [50].

Balanitesa Egyptiaca (Family Balanitaceae): *Balanitesa egyptiaca* has been reported to possess Molluscicidal and cercariacidal activities. Its fruit, bark and other parts have properties lethal to snail intermediate hosts, Schistosomes meracida and cercaria and also to the cercariae of other trematodes [51]. The Molluscicidal and cercariacidal properties of the plant have been studied in Ethiopia [44]. It is commonly known as thorn tree/desert date/soapberry tree. The plant is well adapted to different agro-climatic regions characterized by arid and semi-arid climatic features. It is widely grown in the Sudano-Sahielian region of Africa, the Middle East and South Asia [52]. In Ethiopia, it is found particularly in the Rift Valley areas in GamoGofa, Sidamo and Shoa regions. In addition, it is one of the dominant tree species in the Tigray region of Ethiopia [53]. The fruit, kernel, bark and other parts of the tree have activities lethal to molluscs, meracida and cercariae of schistosomes and Fasciola. It is medicinally used by many countries like Sudan, Nigeria, Egypt and Israel [53].

Phytolacca Dodecandra (Endod): The molluscicide activities of Endod were discovered by Aklilu Lemma in 1964 and have been a breakthrough in combating the

intermediate host snail in schistosomiasis control. In Ethiopia Endod *(Phytolacca dodecandra*), is also called the soap-berry plant and has proven to be a potent molluscicide, killing snail intermediate hosts of trematodes. It is also used by local people as laundry soap for centuries. The species occurs throughout Africa and is familiar to rural populations. It's locally availability and biodegradability, makes it ecologically and economically more acceptable for use in schistosomiasis control compared to synthetic moluscicides [54].

Its berries are the most thoroughly studied as source of the Molluscicidal Saponin with no major toxic properties for other animals and plants [55]. The water extract of the dried and powdered fruit has a potency of killing snails (*Biomphalaria*, *Bulinus* and *Lymnaea* spp.) at a concentration of 10 ppm within 24 hours at room temperature. The green dried fruit extract was the most potent as compared to leaves and buds. Higher potencies were reported from the green and semi-ripe than from the fully ripe berries. Although the preparation and application of the Endod berries is a safe procedure and that the Molluscicidal Saponin is decomposed to water and carbon dioxide in the environment, less detrimental to the ecosphere than the synthetic moluscicides; it is harmful to the snails that are not host snails for trematodes and to fish. It also lacks an ovicidal activity [44].

Plants like *Croton macrostachyus, Ambrosia maritima, Anarcardium occidentale* are found to be cheap, locally produced, biodegradable and effective moluscicide agents in rural areas of developing countries where schistosomiasis and fasciolosis are endemic [56]. *Alium cepa* (Onion) and *Alium sativum* (Garlic) have Molluscicidal effect through disturbing the protein profile, glucose and glycogen content of *Biomphalaria alexandrina* snails [57].

Dry powder of *Capparis spinosa* and *Acacia Arabica* plant leaves have a Molluscicidal potency against *Biomphalaria alexandrina* snails [58]. Dry powder of the aerial part of plant *Cupressus macrocarpa* (Cupressacea), latex of *Euphorbia splendens, Euphorbia conspicua* (Euphorbiaceae) and methanolic extract of *Jatropha curcas* (Euphorbiaceae) are known for their potent Molluscicidal activities [59, 60].

CONCLUSION

Schistosomiasis is one of a zoonotic but neglected tropical disease which is endemic in many developing countries causing considerable loss in humans and animals. The disease affects rural communities particularly those who depend upon irrigation to support their livelihood. The pathogenesis is associated with the deposition of eggs in the mesenteric vein and bladder. Control of schistosomiasis is mainly achieved through repeated population based chemotherapy to reduce intensity of infection and morbidity. Currently, most parts of the world use traditional medicines in the treatment of various diseases including schistosomiasis and it is economically important. Ethiopia is also the land of many indigenous plants with a healing potential of many bacterial, viral, parasitic and other ailments. However, the indigenous knowledge, skill and attitudes associated with the use and transfer of knowledge related to medicinal plant is not growing to the required level to control diseases. Individuals transfer their knowledge through word of mouth for the one whom they believe among their many relatives and even families. Therefore the use of traditional approaches and medicinal plants is limited to individuals.

Based on the above conclusion the following recommendations are forwarded.

- Health education should be given to farmers, children and irrigation workers on proper excretal disposal and to avoid contact with infected water bodies like rivers and ponds.
- Strategic deworming practices should be encouraged in Schistosoma endemic areas.
- An individual with knowledge of herbal medicine has to be motivated and rewarded to share and transfer his/her knowledge in a documented one rather than word of mouth.
- Research activities have to be practiced in areas where traditional practice is there and integrate with modern medicine to produce potential drugs.
- Individuals and the government must give attention on conservation protection, processing, harvesting and packaging of botanical plants through established Policies and legal standards.

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