Schistosomicidal Effects of Neem (*Azadirachta indica* A JUSS: Meliceae) Ethanol Extracts on Schistosomiasis *mansoni in Albino* Mice

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Abstract: - This research was aimed at investigating the schistosomicidal potential of ethanol extracts of *Azadirachta indica* against *Schistosoma mansoni in* albino mice. Plant materials were identified and collected from Central Area of Kano State, Nigeria. Collected roots, leaves, stem bark and seeds were air dried at room temperature, pulverized and subjected to Soxhlet extraction technique for 72 hours using ethanol as solvent. *Biomphalaria pfeifferi* snails were identified and collected and subjected to cercariae shedding by providing artificial illumination. Experimental animals were exposed to *S. mansoni infection* using the tail immersion techniques for 30-40 minutes. Each mouse was given a 125 dose of cercariae. Treatment of infected mice with extracts at different concentrations commenced 7 weeks post infection period and lasted for 14 days. Physical examination of some body organs of infected animals upon dissection reveled varying degrees of variation when compared with the control. Highest liver weight of 2.74g ± 0.12g was recorded among animals treated with REE at 0.001g/ml concentration and the lowest of 1.75g ± 0.02g was found among animals treated with SEE 0.1g/ml. 0.29g ± 0.01g was the highest lungs weight recorded among animals treated with REE at 0.001g/ml while the lowest was 0.15g ± 0.003g among animals treated with SEE at 0.1g/ml. Highest spleen weight recorded was 0.35g ± 0.003g and found among animals treated with REE at 0.001g/ml and the lowest spleen weight of 0.21g ± 0.003 was found in animals treated with LEE at the highest concentration of 0.1g/ml. Highest mean number of worms recovered after treatment was 52.89 ± 2.80 with a 57.69% worm reduction rate and this was recorded among the group treated with REE at 0.001g/ml concentration. The lowest mean number of worms recovered was 6.00 ± 0.00 with a 95.20% worm reduction rate and was recorded among those animals treated with SEE at 0.1g/ml concentration. A significant difference ($p < 0.05$) was found among the different treatments and across concentrations for all extracts. *Azadirachta indica* demonstrated a high level of activity against *S. mansoni,* and the activity was dependent on concentration and type of extract. *A. indica* may serve as an alternative remedy for the treatment of Schistosomiasis infection.

Key Words: — *Schistosoma mansoni, Azadirachta indica, and Ethanol extracts.*

I. INTRODUCTION

Schistosomiasis is considered as one of the Neglected Tropical Diseases (NTDs). The disease is classified in category II alongside malaria in significance as major tropical disease targeted by WHO.

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Almost 240 million people from Asia, South America and Africa are infected with Schistosomiasis (Steinmanni, 2006; WHO, 2022) and about 800 million people worldwide are at risk of infection (Gryseels et al., 2006). Geo-helminths and schistosomes contaminations accounted for over 40% of the tropical disease burden worldwide excluding malaria (Olveda et. al., 2013)).

Schistosomiasis is a disease of poverty and can lead to chronic ill-health. Approximately 120 million people suffer symptoms closely related to Schistosomiasis, while 20 million tolerate suffering as a result of chronic symptoms of the disease, all in Sub-Saharan Africa (Chitsulo et. al., 2000; Mohamed & Yousef, 2021). Despite the heavy disease burden in health and financial perspective, there are limited numbers of available

drugs for the treatment of schistosomiasis (WHO, 2013). This may be connected to the fact that most infected people live in rural areas and are poor, hence the neglect accorded the treatment, prevention and control of the disease (Chacha et al., 2019). Suitable *Schistosoma* control programs includes, mass chemotherapy, using praziquantel, education focusing on behavoiur changes towards risk factors, public health, improving sanitation, provision of clean water supply and snail control (Kiros et al., 2014). Praziquantel is the drug of choice and now faces challenges of selective efficacy and resistance leading to the reduced cure rates and the failure of treatment (Fallon, 1998; Botross and Bennett, 2007; Aly et al., 2010). It is therefore most importance to search for readily available, safe and reliable drugs to treat schistosomiasis, to augment the available drugs. Africa is rich in medicinal plants and these plants have been employed for decades in the treatment of many health conditions and helminthic infections including schistosomiasis (Morayi, 2011). Medicinal plants have been used as alternative treatment in place of synthetic drugs for many diseases especially parasites in modern medicine. Their natural compounds or plants extracts of many have shown strong efficacy against Schistosomiasis (Mølgaardet al., 2001; Yousif et al., 2012).

Azadirachta indica (Neem) tree belongs to the family meliaceae and is found in abundance in tropical and semi tropical regions including, Bangladesh, India, Pakistan, and Nepal. It is a fast-growing tree about 20-30m tall, and the trunk is straight with a diameter around 4-5ft. It has compound leaves, imparipinnate, with each comprising 5-15 leaflets. Its fruits are green drupes which turns golden yellow on ripening. *Azadirachta indica* has a complex mixture of different constituents including, nimbin, nimbidin, nimbolide, and limonoids and these types of ingredients play crucial roles in disease management through the modulation of various genetic pathways and other activities. This study was aimed at investigating the schistosomicidal potential of different parts of the plant *Azadirachta indica (neem)* against *S. mansoni* in albino mice.

II. MATERIALS AND METHODS

2.1 Collection, Drying and Extraction of Plant Materials

Plant parts used for this work include the root, stem bark, leaf and seed. Matured fruits and leaves were collected directly from the plant by hand picking. Stem bark and root were obtained from the plant with the aid of a cutlass. Roots found deep in the soil were traced to the base of the plant before cutting. Collected plant parts were kept in different plastic bags and transported to the laboratory. The roots and stem bark were quickly rinsed in clean top water to remove dirt. The epicarp and mesocarp of matured fruits were removed leaving only the endocarp and seed. Leaves were dusted to remove dirt. All plant materials were air dried at room temperature. Dried plant materials were then crushed and ground to powder. Extraction of each plant part was carried out using the Soxhlet extraction technique for 72 hours and using ethanol (70%) as the solvent. Each extract was transferred into a 200ml beaker and evaporated to dryness using water bath at 50°C. Extraction of plant material was carried out at 78°C. Extracts were labelled SEE, BEE, LEE and REE for seed, stem bark, leaf and root ethanol extracts respectively.

2.2 Collection and Culturing of snails and Cercariae Harvest

Highly endemic *Schistosoma mansoni* area in Jos, Plateau State was identified. *Biomphalaria pfeiferi* snails were identified and collected from this area. Snails were collected according to the method described by Christensen *et al*., (1984). Snail collection was carried out along three different types of terrace i.e narrow steep, broad shallow and gentle shelving terrace at point water and very shallow, mud fat terrace which becomes at least partially exposed to low tide, according to the method used by Appleton and Lethbridge (1979). These sites were selected not only because they represent different littoral habitats but also because they are important foci of schistosome dermatitis transmission. Snails were transported in clean plastic container to the laboratory, maintained in an aquarium, covered with dark cloth to prevent shedding of cercariae and fed with lettuce. Snails were maintained according to the method described by Christensen *et al*., (1984) and Dakul *et al*. (2000). Snails were exposed to artificial illumination for cercariae harvest and cercariae were enumerated using the Christensen *et al*. (1984) method.

2.3 Ethical Clearance

Ethical clearance was obtained from the ethical committee, Department of Pharmacology, Faculty of Pharmaceutical Sciences, University of Jos. An ethical clearance certificate was issued with reference: Assurance Approval Number UJ/FPS/F17-00379.

2.4 Experimental Animals and inoculation

Albino mice were obtained from the Animal house, Department of Pharmacology, University of Jos, Nigeria and maintained in plastic cages. Mice were fed with grower's mash (Chicken feed) with the following ingredients and composition.

Cereals/Grains, Animal Protein, Vegetable protein, Mineral, salt, Essential Amino Acids, Antibiotics, Antioxidant and Vitamin pre mix. The composition includes crude protein 14.50%, Fat 5.70%, crude Fibre 7.20%, Calcium 0.80%, Available phosphorus 0.40% and metalisable energy 2,400cal/kg. The pelletized growers feed was soaked with little water and served in balls to the mice. Clean top water was also made available and served in water bottles.

The tail immersion technique described by Christensen et al., (1984) was used to infect the mice. The inoculation of mice lasted for 30-40 minutes for each mouse. Each mouse was given a dose of 125 cercariae. Mice used for this study weighed between 24-30g.

2.5 Treatment of Experimental Animals

Mice were treated for two weeks using different concentrations of the extracts. Mice were kept in cages (3 per cage) and replicated 3 times for each treatment. The mice were given 0.2ml of the extract orally using a syringe and cannula for easy administration. A set of mice replicated 3 times were infected but not treated (UT) serve a control. Another set replicated 3 times, not infected and not treated (UI), this also served as a control. Treatment of mice commenced after the establishment of infection (7 weeks post infection period), when eggs were detected parasitologically in faeces.

2.6 Perfusion and Worm Recovery

Mice were sacrificed by an intraperitoneal injection of Nebutal solution. Upon sacrifice and dissection, each mouse was perfused according to the method described by Christensen et al. (1984). The liver, lungs and spleen physical appearances were noted, weighed and preserved.

2.6.1 Recovery of Schistosome Adult Worms

Recovery of adult worms upon dissection was carried out using the method of Christensen *et al*. (1984). Additional worms were recovered by placing the various tissues in normal saline for about 60 minutes.

2.7 Data Analysis

Data were analyzed using Statistical package for Social Sciences (SPSS) version 25 (IMB Corp.) New York. Data were represented in in tables and cluster bars charts. One way and two-way ANOVA analysis was used to determine relationship between concentrations and treatments. Level of significance was set at $p < 0.05$.

III. Results

3.1 Experimental Animals and Infection

All experimental animals infected were carefully monitored for the first 3- 7 days post infection period. They all showed no sign of infection. All animals were active as they were during the pre-infection period and consumed almost the same quantity of food daily. Gradual decrease in activeness was observed at about the 4th and 5th weeks post infection period. Evidence of infection was established at the end of the 6th week, by the presence of ova in faecal samples examined using the concentration method as described by Chessbrough (2005).

3.2 Condition of Examined Organs

3.2.1. Liver Conditions

All infected animals' liver showed mottling and darkening. However, there were variations according to treatment (extracts) and concentrations.

Animals treated with the Seed Ethanol Extracts (SEE) at the highest concentration (0.1g/ml) had less mottling and darkening, while those treated with the Root Ethanol Extract (REE) at lowest concentration (0.001g/ml) had more mottling and darkening of the liver than others. Measurement of liver weight indicated that, weight of liver decreased as the concentration increased across extracts.

The mean highest liver weight of 2.74g±0.12g was observed among animals treated with REE, with a concentration of 0.001g/ml (Table 1) while the lowest mean liver weight of 1.75g±0.02g was observed among animals treated with the SEE, with a concentration of 0.1g/ml. Untreated (UI) animals had a mean liver weight of 3.19g±0.12g while the Uninfected mice had a mean liver weight of 1.71g±0.02g. Adult Schistosome worms were also recovered from some livers F-ratio of 363.59 and 11.00 for the different concentrations and different extracts respectively indicated significant difference in the liver weight at 95% level of significance ($P< 0.05$).

Two-way Analysis of variance and Duncan post hoc test revealed a significant difference in all the three (3) concentrations on liver weight and also differences in the plant parts. Significant difference exists between SEE and LEE, SEE and BEE. However, LEE and BEE differed insignificantly from each other.

3.2.2 Lungs Condition

All examined infected lungs indicated no physical damage or signs of infection but they all appeared anaemic on sight compared with the uninfected animals (UI) lungs. Lung weight was observed to decrease as concentration increased in all extracts. The highest mean lung weight 0f 0.29g±0.01g was observed among animals treated with REE (Table 1) at a concentration of 0.001g/ml, while the lowest mean lung weight of 0.15g±0.003g at a concentration of 0.1g/ml was observed among animals treated with SEE (Table 4). Untreated mean lungs weight was 0.36g±0.02g while the uninfected (UI) mean weight was 0.14g±0.01g. An F- ratio of 272.62 and 15.27 for the concentrations and among different extracts respectively indicated a significant difference at 95% level of significance ($P < 0.05$).

Two-way ANOVA and Duncan Post Hoc test indicated a significant difference among the concentrations and between the extracts. SEE and BEE, LEE and BEE, and LEE and REE are significantly different ($P < 0.05$). There was a significant difference between BEE and REE ($P< 0.05$)

3.2.3 Spleen condition

Examination of the spleen without an aid revealed no physical signs of infection but there was little colour variation and spleen sizes varied. The highest mean spleen weight of 0.35g±0.003g was observed among animals treated with REE at a concentration of 0.001 g/ml (Table 1). The lowest mean spleen weight of 0.21g±0.003g was observed in animals treated with LEE an at 0.1g/ml concentration (Table 2). Untreated (UT) mean spleen weight was 0.40g±0.00g and uninfected spleen weight of 1.80g±0.006g were recorded. An F-ration of 1335.55 and 51.42 within concentrations and different extracts indicated a significant difference at 95% level of significance as compared to the control. For the extracts there was a significant difference between SEE and BEE and REE. There was however no significant difference between BEE and REE.

3.3 Adult worms recovered

Adult worms were recovered from the infected animals (from the liver and mesenteries). Some worms were dead while others were alive. The number of worms recovered varied with the type of extract and also with concentration. The mean highest number of 52.89±2.80 and a percentage worm reduction of 57.69% of adult worm were recovered from animals treated with 0.001g/ml of REE (Table 1) and the lowest mean number of worms 6.00±0.00 with a percentage worm reduction of 95.20% was recorded in animals treated with SEE at 0.1g/ml concentration (Table 4). F-ratio of 2301.83 and 135.73 within concentrations and the different extracts indicated a significant difference at the 95% level of significance ($P< 0.05$). Duncan Post Hoc test from the two ways Analysis of variance revealed a significant difference between all concentrations while between the extracts, there was a significant difference SEE and BEE, LEE and REE, and BEE and LEE, while there was a significant difference between LEE and REE

Table.1. Effects of REE of *A. Indica* on different parameters studied in mice infected with *S. Mansoni*

Conc (g/ml)	Liver weight(g)	Lungs Weight (g)	Spleen weight (g)	No. of worms Recovered	% worm Reduction
0.001	$2.74^{c} \pm 0.23$	$0.29^{c} \pm 0.01$	$0.35^{c} \pm 0.003$	$52.89^{c} \pm 2.80$	57.69
0.01	$2.54^{b} \pm 0.03$	$0.26^{bc} \pm 0.003$	$0.27^{c} \pm 0.002$	$41.20^{c} \pm 21.42$	67.04
0.1	$2.26^{a} \pm 0.02$	$0.22^{b} \pm 0.003$	$0.23^{b} \pm 0.003$	$41.55^{b} \pm 3.27$	66.76
UT	$3.19^{e} \pm 0.12$	$0.36^{d} \pm 0.02$	$0.40^{d} \pm 0.00$	$117.00^{d} \pm 1.73$	-
UI	$1.71^{d} \pm 0.02$	$0.14^{a} \pm 0.01$	$0.18^{a} \pm 0.006$	-	-

SEE- Seed Ethanol Extract, REE- Root Ethanol extract, LEE-Leaves Ethanol Extracts, BEE- Bark Ethanol Extract, UT-Untreated, UI- Uninfected, entries with same superscripts on the same columns share no significant difference, ($P = 0.05$)

Table.2. Effects of LEE of *A. Indica* on different parameters studied in mice infected with *S. Mansoni*

Conc (g/ml)	Liver weight(g)	Lungs Weight (g)	Spleen weight (g)	No. of Worms Recovered	% Worm Reduction
0.001	$2.61^{c} \pm 0.03$	$0.24^{c} \pm 0.01$	$0.26^{d} \pm 0.007$	$24.78^{c} \pm 0.97$	79.38
0.01	$2.22^{b} \pm 0.00$	$0.21^{bc} \pm 0.006$	$0.22^{c} \pm 0.00$	$21.45^{c} \pm 1.54$	82.84
0.1	$2.06^{b} \pm 0.03$	$0.20^{b} \pm 0.00$	$0.21^{b} \pm 0.003$	$12.56^{b} \pm 1.06$	89.95
UT	$3.19^{d} \pm 0.12$	$0.36^{d} \pm 0.02$	$0.40^{e} \pm 0.00$	$117^{d} \pm$ `1.73	-
UI	$1.71^{a} \pm 0.02$	$0.14^{a} \pm 0.01$	0.18 ± 0.006	-	-

SEE- Seed Ethanol Extract, REE- Root Ethanol extract, LEE-Leaves Ethanol Extracts, BEE- Bark Ethanol Extract, UT-Untreated, UI- Uninfected, entries with same superscripts on the same columns share no significant difference ($P = 0.05$).

Table.3. Effects of BEE of *A. Indica* on different parameters studied in mice infected with *S. Mansoni*

Conc (g/ml)	Liver weight(g)	Lungs Weight (g)	Spleen weight (g)	No. of Worms Recovered	% Worm Reduction
0.001	$0.25^{c}\pm 0.09$	0.27 ± 0.01	$0.33^{d} \pm 0.01$	$37.67^{c} \pm 2.41$	69.86
0.01	$0.23^{c} \pm 0.00$	0.23 ± 0.00	$0.27^{c} \pm 0.003$	$26.45^{c} \pm 1.78$	78.84
0.1	$2.15^{b} \pm 0.04$	0.21 ± 0.03	$0.23^{b} \pm 0.01$	$22.44^{b}\pm 0.59$	81.96
UT	$3.19^{d} \pm 0.12$	0.36 ± 0.02	$0.40^{e}\pm 0.00$	$117.00^{d}\pm 1.73$	-
UI	$1.71^{a} \pm 0.02$	0.14 ± 0.01	$0.18^{a} \pm 0.006$	-	-

SEE- Seed Ethanol Extract, REE- Root Ethanol extract, LEE-Leaves Ethanol Extracts, BEE- Bark Ethanol Extract, UT-Untreated, UI- Uninfected, entries with same superscripts on the same columns share no significant difference, (P= 0.05)

Table.4. Effects of SEE of *A. indica* on different parameters studied in mice infected with *S. Mansoni*

Conc (g/ml)	Liver weight(g)	Lungs Weight (g)	Spleen weight (g)	No of Worms Recovered	% Worm Reduction
0.001	$2.52^{c}\pm 0.020$	$2.20^{c} \pm 0.02$	$0.28^{b}\pm 0.03$	$19.22^{d}\pm 0.73$	84.62
0.01	$2.20^{b}\pm 0.021$	$0.25^{b}\pm 0.09$	$0.25^{c}\pm 0.21$	$10.55^{c} \pm 2.03$	91.56
0.1	$1.75^{a}\pm 0.02$	$0.15^{a} \pm 0.003$	$0.21^{b}\pm 0.007$	$6.00^{b} \pm 0.00$	95.20
UT	$3.19^{d} \pm 0.12$	$0.36^{d}\pm 0.02$	$0.40^{e} \pm 0.00$	$117.00^{e}\pm 1.73$	
UI	$1.71^{a}\pm 0.02$	$0.14^{a} \pm 0.01$	$0.18^{a} \pm 0.006$	-	

SEE- Seed Ethanol Extract, REE- Root Ethanol extract, LEE-Leaves Ethanol Extracts, BEE- Bark Ethanol Extract, UT-Untreated, UI- Uninfected, entries with same superscripts on the same columns share no significant difference, (P = 0.05)

Fig.1-3 showed the comparison between weight of organs and type of extract while fig.4, indicated a comparison in the number of worms recovered after treatment and type of extract.

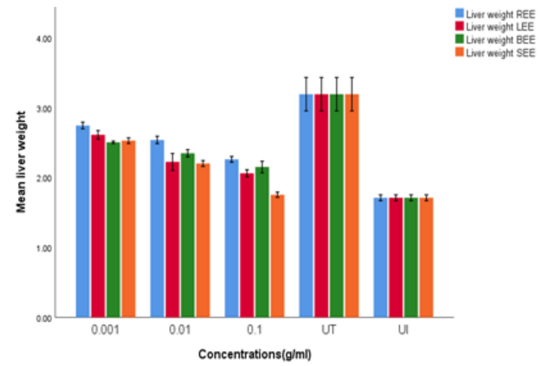

Fig.1. Effects s of *A. indica* extracts and concentrations liver weight of mice infected with *S. mansoni*

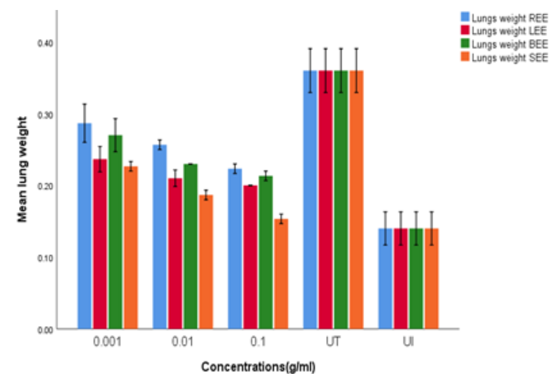

Fig.2. Effects of *A. indica* extracts and concentrations on lungs weight of mice infected with *S.mansoni*

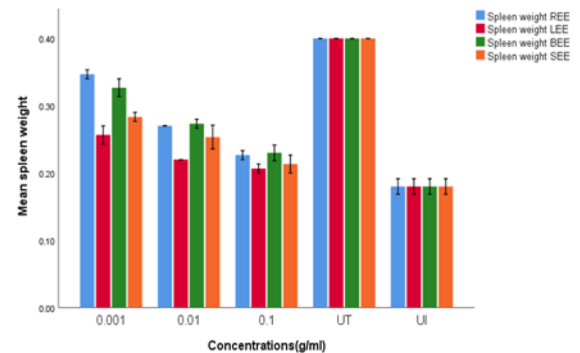

Fig.3. Effects of *A. indica* extracts and concentration on spleen weight of mice infected with *S.mansoni*.

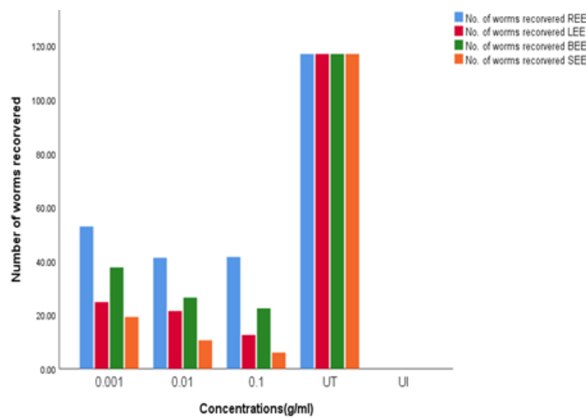

Fig.4. Effects of *A. indica* extracts and concentrations on number of worms recovered from mice infected with *S.mansoni.*

IV. Discussion

Schistosomiasis is one of the chronic threatening but neglected parasitic disease caused by worms under genus *schistosoma*. Despite the seriousness of the disease in health and financial perspective, there are limited numbers of drugs for treatment of the disease. There are two drugs namely praziquantel and oxamniquine recommended by WHO for treatment of schistosomiasis. Despite being the only drugs available for the treatment of the disease, the drugs are facing the challenge of resistance (Mbugi, et al., 2019). Thus, it has become a paramount to develop new compounds that can treat schistosomiasis alongside these recommended drugs (Campelo, et al, 2018; Lago, et al, 2018). Because of the high range of biological activities and molecules provided by natural products they are seriously considered as an alternative to the most common or chemical compound. Even though there are advancements in biotechnology, and genomics, chemistry etc discovering new drugs to treat Schistosomiasis remains vital (Lago, et al., 2018; Silva, *et al*., 2017). In this study, the effectiveness of the compounds to be tested on schistosomiasis was determined on various strategies such as effects on worm reduction and on the weights of some body organs.

Different factors influence the chemical composition of plant materials (Per Molgaard *et al*., 2001) and these factors may include the season and time of day the plant material was harvested, together with variations in harvest conditions. Since this study was based on a single set of samples of a particular plant from a particular region, the result may underestimate the activity of the plant species involved.

The different plant parts studied did not come out with the same activity as shown in the tables and figures. Although all plant parts showed activity against *S. mansoni*. This coincides with the findings of Hanan, et al., (2016) who showed that the anti schistosomicidal potential of Neem plants on *Schistosomia mansoni* and went further to suggest its use in the management of Schistosomiasis. Although all plant parts showed activity against *S. mansoni*. These activities varied with the different plant parts extracts and across concentrations. The result of this study showed that *A. indica* extracts were effective in reducing the worm burden when compared with the infected untreated mice, indicating their effective antischistsosomal action. This also agrees with the findings of De Oliveira and Coweker, (2014); Hanan, et al., (2016) and Mbugi, et al., (2019).

The percentage worm reduction indicated activity against adult worms. A percentage worm reduction of 95.20% and 89.95% in the mice treated with SEE and LEE respectively indicated that these plant parts could be more active than the other two. Generally, in all the plant parts studied, there was a higher activity potential observed in the SEE compared to others. This finding agrees with the reports of Kaul (1990) and Schmuttere (1990) who stated that Neem seeds contains the highest concentration of Azadirachtin and other biologically active compounds. Ascher (1993) stated that other tissues of *A. indica* are known to contain these compounds at lower levels are the bark, leaves and heart wood. The anti-feedant effects of azardirachtin are well documented. Azadirachtin plays roles as an antimicrobial and insecticide agent and it more present in seeds (Jose, et al., 2020). This may have resulted to the death, elimination and number of worms observed in mice treated with SEE and LEE.. In general, most groups recorded lesser mean spleen, liver and lungs weight compared to the untreated groups this agrees with the findings of Desmong *et al*. (2020) who recorded than mice treated with *A. indica* resulted in lesser liver and spleen weight compared to the untreated groups. The lowest percentage (57.69%) worm reduction of revealed that the neem plant is highly Schistisomicidal. Some authors demonstrated and attributed the death of worms due to the treatment with anti shistsosomal drugs to metabolic disorders, mechanical destruction and muscular contraction of treated worms (Doenhoff *et al*., 2002; Ibrahim *et al*., 2010, Emam *et al*., 2009; Hanan, et al., 2016). The results of this study also agree with the findings of Musili *et al* (2015) who evaluated *A. indica* extract for their potential anti-schhistosome properties against adult worms. His findings however, showed a higher activity on juvenile worms and a considerable anti-schistsome properties against the adult worms. The reduction in the

parasitic egg loads observed could be due to induction of the separation of males and females which in turn reduces or even completely arrests the release of eggs, worm load especially in female worms. The anti-schistosome effects of these extracts on worms indicated that this plant can be used as a complimentary drug or in combination with conventional drugs such as PZQ or Mirazid for effective management of the disease (Transatit et al., 2012; Musili et al., 2015; Hanan, et al., 2016). Similar findings have been reported on the effects of other plants against schistsosome at different cercarial stages, schistsosomula and adult worms (Mbugi, et. al., 2019). Mostafa et al. (2011) reported on the schistosomicial activity of crude aqueous extract of ginger against *S. mansoni*, they observed that the parasitic load and egg density in the liver and the faeces of mice treated with ginger were less than their counter parts. Male worms recovered from ginger treated mice lost their surface architecture, extended erosion beyond the tegument, besides numerous bubbles and tubers. It was also reported by Mahmoud *et al* (2002) that treatment of mice infected with *S. mansoni* parasites using black seed oil was effective in reducing egg counts in both liver and intestine. Trapped eggs were observed in some of the organs. The pathology of Schistsosomiasis consists of a series of chronic inflammatory lesions produced around blood vessels by eggs or their products and sometimes adult worms (Ahmed and Maha, 2000). Most of the ova found in tissues in this study were trapped in the intestine, lungs and also liver. Miracidia of these trapped ova produce egg antigens, leading to sensitization of T-lymphocytes which release lymphokines and inflammatory response is evoked (Ahmed and Maha, 2000). Several studies have answered whether or not liver fibrosis in schistosomiasis is reversible. Though there was a high reduction of worm load observed in this study, this however did not affect the appearance of the tissues of mice studied 10 weeks post infection and treatment period. This signifies that though the plant extract may be highly effective, tissue lesions were irreversible after 7 weeks post infection period in mice. This is in confirmation to the report by Ahmed and Maha, (2000), which stated that the destruction of parasites in the late stage of Schistosomiasis is not followed by any striking reversal of either clinical signs or symptoms of liver lesions. Hence the extracts from this plant can be used in the treatment of schistosomiasis infection.

V. CONCLUSION

All plant extracts demonstrated a high level of activity against *Schistosoma mansoni.* It was however observed that these activities vary according to the plant extracts and also concentration dependent. The highest and lowest schistosomicidal activities were observed in the seed and root ethanol extracts respectively. However, since this study was carried out using a particular plant from a specific region, there may be limitations due to environmental conditions as to the full potentials of the plant against *S. mansoni*. Further studies should be conducted to ascertain the full schistosomicidal potential of the plant, its phytochemical compounds and toxicity profile of the extracts.

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