J. Emerg. Sci. Eng. 2023, 1(2), 63-74

Contents list available at CBIORE journal website

Journal of Emerging Science and Engineering

Journal homepage: https://journal.cbiore.id/index.php/jese/index

Review Article

Significance of *Balanites aegyptiaca* (L.) as Molluscicide against *Bulinus wrighti* (Mandahl, 1965) snails: A review of concepts

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Abstract. The objective of this paper is to bring a conceptual review of schistosomiasis and application of Balanites aegyptiaca in controlling the host (Bulinus wrighti) of the disease. The snail host (Bulinus wrighti) serve as the host that transmits schistosomiasis disease to humans; therefore, for effective management it shall be controlled. Whereas, schistosomiasis is mostly due to the parasites, S. haematobium, S.japonicum, S. mekongi, and S. intercalatum. Those parasites deposit their eggs in freshwater environment that tend to further develop in snail. Snail shed numerous cercariae that under opportunity invade the human body (for example, farmers, fishers, swimmers, etc). In the human body, the schistosomule is made from the cercariae; thereof allowed to be transported to various body parts (such as liver, messentric veins) depending on the specific parasite involved. Thereafter, eggs are formed and definitive host reactions are elicited in form of clinical portends (such as cough, fever, abdominal pain, fatigue, skin symptoms) in respective of the parasite species. In Africa, millions of individuals are infected, and millions are at risk. To prevent the disease, natural or synthetic mollusucicides could be applied to kill the snail. Natural products such as Balanites aegyptiaca are proven with good virtues to act as mollusicides. B. aegyptiaca in its various parts contain active compounds such as saponins, tannins, alkaloids, terpenoids, flavonoids, etc that might be responsible for the activities of the plant. Therefore, it is relevant to advocate for natural-bases products such as B.aegyptiaca for prevention of schistosomiasis due to accessibility, cheapness, effectiveness, poverty, and culture-based traditions.

Keywords*:* Freshwater, schistosomiasis, *Balanites aegyptiaca*, phytochemicals, death, disability, Africa

Received: 2nd November 2023; Revised: 24th Dec 2023; Accepted: 26th Dec 2023 2024; Available online: 9th Jan 2024

1. Introduction

Verily, schistosomiasis remains among the most spread parasitic infections nowadays. Many countries across regions of the world in Africa (tropical), Central America, South America, Carribean, Far East, and Middle East (Abdulhadi and Talaat, 2022). Each year about 200 million people of the world are infected and 600 million are at the risk of the infection. 10 % of the infected show clinical severe symptoms (about 20 million); and 180 million show symptoms that are of public health concern (CDC, 2018). Blood flukes from the genus Schistosoma are responsible for schistosomiasis; therewith, about 5 trematodes were reported to have infected human body. The species include, *S. haematobium, S. mekongi, S. japonicum, S. masoni,* and *S. intercalatum* (Anthony *et al.*, 2019). The disease is responsible for about 280 00 deaths every year, and leading to 3.3 million DALYs (Disability-Adjusted Life Years) (Nelwan *et al.,* 2019). Elimination of snails (the host) and sanitation interventions are key to control the disease nowadays. However, the methods for control and prevention of the disease are still debated (due to pollution effects of synthetic chemicals), especially considering the nature of many rural areas around the world (characterized with poverty, poor healthcare, and culture) (Anyolitho *et al.,* 2022).

Considering the nature of plants due to the inherent natural compositions of specialized chemicals (phytochemicals), cheapness, effectiveness, and accessibility; they are supposed to be used as tools for elimination of schistosomiasis host to safeguard public health (Audu *et al*., 2019; Kanam and Galadima, 2021). For instance, in many regions of Africa (semidesert and desert areas) there is presence of abundant *B. aegyptiaca. B.aegyptiaca* can be found available in more than 20 countries of the world, contains phytochemicals for its potential utilization in pest and diseases prevention (Karaye *et al*., 2020; Abdulkarim *et al.,* 2023).

Many empirical studies argued that, the use of *B. aegyptiaca* for therapeutic and pharmacological aspects was because of disparate bioactive chemicals (Karaye *et al.,* 2020). Therefore, it is important to shade more light using conceptual review framework about the effectiveness of using *Balanites aegyptiaca* for schistosomiasis host (snail) control. The objective of this paper is to bring a conceptual review of schistosomiasis and application of *Balanites aegyptiaca* in controlling the host (*Bulinus wrighti*) of the disease.

2. Biology of intermediate host snail

Snails belong to the phylum Mollusca, class Gastropoda, and family Planorbidae, (Despommier, 2010). Snails are triploblastic and bilaterally symmetrically animals with anus and colon, but without segmentation. They usually have shell and a characteristics ventral muscular foot. Molluscs are of major interest to man as about 10,000 species are of economic importance. Mostly they are beneficial to

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https://doi.org/10.61435/jese.2023.e27
ISSN: p-ISSN: 3026-0817; e-ISSN: 3026-0183.The Author(s). Published by CBIORE

man although there are some molluscs which act as intermediate hosts of some diseases. Some snails serve as food. Chitons formed the main food of Red Indians. The gastropods are consumed by numerous predators' chiefly fish, birds and mammals. Many gastropods (Cuvier) are very useful to man, as bait for catching fish. Squids make excellent bait for marine fishers especially cod in United States. Red Indian tribes of American used the common *Dentallium indianorum* (Fischer) as money. Values of shells varied lengthwise. Gastropodan shells were source of money for various native races, including vampum of American Indians. American oyster, *crassostria viginica* (Gmelin), is commercially cultivated and harvested and provides millions of dollars to the industry. Scaphod, *Dentallium indianorum,* tooth shells are valued as ornaments. Tools, utensils and objects of delight have been formed from *gastropodan* shells. Some gastropods like *Nucella* (Roding), *Purpura* (Bruguiére) and Murex (Linnaeus), are sources of Tyrian purple from their juice. Dye for royal purple in Biblical literature originally came from a gland of the snail, *Murex truncutus* secretion is colorless but becomes a beautiful purple by exposure to the air. Originally Indian ink was obtained from the ink of a cuttle-fish, *Sepia cubrata*. Nowadays a brown finish of photograph is termed as sepia finish (Kotpal, 2009).

Gastropodan shells are used to manufacture buttons and other articles. Shells cameos are made mostly from snails notably that *Cypraea tigris* (Linnaeus) and causes tuberose. Nautilus shell is commonly used in art. The "cuttle-borne" is used as medicine as well as for other purpose. The destruction activities of some mollusks are of great importance to global economy. Some gastropods like slugs and snails cause damage to gardens, orchard, green houses and mushroom beds by feeding upon the succulent parts of seedlings and mature plants. Some gastropods are ferocious predators (Natica), Buccinum (Gray), Murex, *Urosalpinx* (Say), that bore into and feed on other mollusks. Members of the families *pyramidellidae* (Gray) (e.g. *Brachystomia*) and *Eulimidae* (Philippi) of gastropoda are ectoparasites and suck blood from bivalve molluscs, polychiaetes (Grube) and Echinoderms. Stylifer (Broderip and Sowerby) (family styliferidae) is an endoparasites in the wall of Echinoderms. Snails are of considerable importance from a medical point of view as many of them serve as an intermediate host for parasitic flat worms, such as *Fasciola* and *Schistosoma* (Kotpal, 2009).

Snails belong to the Phylum Mollusca and class Gastropoda. They are triploblastic, bilaterally Symmetrical Animals with anus and coelom and without segmentation. They usually have shell and a characteristic ventral Muscular foot. There are 80,000 known living species in this Phylum. In number of species, the mollusca is the second largest phylum after Arthropoda. Some mollusks are herbivorous while others are carnivorous. The digestive system is largely extracellular. They mostly have ganglionated nervous system and the ganglia have a tendency to become concentrated at the anterior end. The nephridial wall tends to become evaginated and folded to effect an increase in the surface area for tubular secretion of waste picked up from circulatory blood. The gonads have lost their primitive association with the pericardial cavity and have mounted on special axis to the outside (Kotpal, 2009).

The body of snail consists of foot (sole), a head and a coiled visceral mass that is located in the shell. Movement takes place by means of expanding and extracting muscles in the foot. Mucus glands located in the anterior (front) part of the foot secrete mucus. There are also mucus glands on the rest of the body protecting the snail against loss of water. Two pairs of tentacles are placed on the head, in branch proso gastropods there is only one pair. The upper pair bears the eyes. The shell is secreted by a thick fold of skin, called the mantle. The shell is connected to the body through a strong muscle which is attached to the columella. It has branches to the head and tentacles. Contracting this muscle enables the snail to withdraw in its shell. Inside the shell it forms the mantle cavity which holds the heart, kidney and lung. In prosobranchs the mantle is open at the front, and in the roof is a plumate or a pectinate gill. In terrestrial prosobranchs the gill has been lost (Nelwan *et al.,* 2019).

The digestive system of gastropods (slugs and snails of every kind) has evolved to suit almost all kind of diet and feeding behavior. Gastropods as the largest taxonomist class of the mollusca are very diverse indeed: the group includes carnivores, herbivores, scavengers, filter feeders, and even parasites. In particular, the radula is often highly adapted to the specific diet of the various group of astropods. Another distinctive feature of the digestive tract is that, along with the rest of the visceral mass, it has undergone tortion, twisting around through 180 degerees during the larval stage, so that the anus of the animal is located above its head. A number of species have developed special adaptations to feeding, such as the "drill" of some limpets, or the harpoon of the neogastropod genus *conus*. Filter feeders use the gill, manele lining or net of mucus to trap their prey, which they then pull into the mouth with the radula. The highly modified parasitic genus *Enderoxenos* has no digestive tract at all, and simply absorbs the blood of its host through the body wall (Nelwan *et al*., 2019).

The digestive system consists of the following parts:

Buccal mass (including the mouth, pharynx, and retractor muscles of the pharynx and salivary glands with salivary ducts), Oesophagus and oesophagal crop,Stomach, also known as the gastric pouch, Digestive gland, also known as the hepato pancreas, Intestine and Rectum and anus (Fenwick, 1987). The mouth has a tongue called radula. In the top of the mouth is a hard ridge and food is being mashed between the radula at this ridge. The front teeth of the radula wear very fast but the radula grows from the backend. Near the opening of the mouth salivary glands release digestive enzymes. The salivary glands secretions moisten the digested food and envelop them, thereby making it easier for the food to go into the oesophagus. The oesophagus ends in the stomach. The intestine release large quantities of the brown digestive juice in the stomach. The intestinal gland fills up most of the space in the visceral sac. The intestinal gland consists of smaller and bigger follicles. A steady back and forth movement of the digestive juice between stomach and intestine enhance the process absorption of the food (Nelwan *et al*., 2019).

The movement of the digestive juice is caused by the muscles of the intestinal glands and ciliae. The digested food flows over the liver cells which absorb the food. The smaller intestine starts at the visceral sac it follows the edge of the kidney and enters the pulmonary cavity. It ends near the pneumostome (breathing pore). In the smaller intestine is on the point of exit from the visceral sac a deep groove. This groove which is coated with cilia takes over all non-absorbed solids and directs it into the small intestine. There the solids are compressed and enveloped with a layer of slime after which they leave the body. The kidney of a snail lays as a yellowish, triangular, organ in the rear segment of the lung. One of the sides of the kidney runs parallel to the intestine, the other side is arranged closely to the pericard. The kidney consists of two parts: the kidney cavity where the excrements are secreted and the primary urethra, in which the first part of the discharge of the excrement takes place. This goes then to a second segment, the secondary urethra, where it leaves the body (Fenwick, 1987). Snails living on the land are uricotelic, this means that to preserve water they excrete almost solids uric acid. Snails living in the water excrete ammonia, and are not uricotelic. The blood system in snails is open, with blood spaces and no veins the pigment is colourless, and is called haemocyanin, which contains copper (Fenwick, 1987).

The relative weak heart consists of a single thick walled ventricle and a single thin walled auricle. The blood takes oxygen from the lung and transport it to the auricle, and then to the ventricle. The ventricle releases blood with oxygen in arteries, after which the blood goes to the tissue. The tissue takes oxygen and food from the blood and excretes waste products. The blood flows back to the lung by means of blood spaces instead of veins. The central nerve system of snails consists of paired nerve knots or ganglia they have different functions. The cerebral ganglia for the sense in the head, the buccal ganglia for the mouth, the pedal ganglia for the muscles in the foot, the pleural ganglia for the mantel and the intestinal ganglia for the organs. A separate, not paired ganglia is located under the intestines this is named the visceral ganglion. For reproduction, temperatures between 22^0c and 26^0c are usually optimal, but *Bulinus* snails in Ghana and other hot places have a wider temperature range. The snails can easily survive between 10^0c and 35^0c. They are not found in salty or acidic water. (Fenwick, 1987)

Snail habitats include almost all types of fresh water bodies ranging from small temporary ponds and streams to large lakes and rivers. Within each habitat, snail distribution may be patchy and detection requires examination of different sites. Moreover, snail densities vary significantly with the season. In general, the aquatic snail host of *Schistosomes* occur in shallow water near the shores of lakes, ponds, marshes streams and irrigation channels. They live on water plants and mud that is rich decaying organic matter. They can also be found on rocks, stones or concrete covered with algae or on various types of debris. They are most common in waters where water plants are abundant and in water moderately polluted with organic matter such as faeces and urine, as is often the case near human habitations. Plants serve as substrates for feeding and oviposition as well as providing protection from high water velocities and predators such as fish and birds (Gryseels, 1989).

Some snails live on land and some live in water (aquatic). The snails can be divided into two main groups; aquatic snails that live under water and cannot usually survive elsewhere (*Biomphalaria*, *Bulinus*) and amphibious snails adapted for living in and out of water (*Oncomelania*). The body of snail is soft but snails have perfect home which is their shell. The snail can retreat into its shell when danger threatens. The spiral shell gives it protection from predators and from being damaged. Land snails are very well adapted to changing weather conditions. Some land snails have very thick shells. Snails that live in moist areas usually have thinner shells. Some snails that live in the desert can stay sealed in their thick shells for two or more years. Some types of snails are called " burrowing snails." These are only found above ground in rainy season. When the weather is hot and dry they burrow about 7.5 to 15cm into the ground and become dormant until rain soften the ground. In Africa and Americas, snails of the genus *Biomphalaria* serve as the intermediate hosts of *S. mansoni (*Sambon). Snails of the genus *Bulinus* serve as the intermediate hosts of S. *haematobium* in Africa. The genera that are found to be implicated in transmission of schistosomiasis in Nigeria are *Bulinus* (Muller) and *Biomphalaria* (Preston). In south-east Asia, *Oncomelania* (Gredler) serves as the intermediate host of S. *japonicum* (Katsurada), and *Tricula* as the intermediate host of *S. mekongi.* Among the snail intermediate hosts of trematodes, the species belonging to the genus *lymnaea* are of importance in the transmission of liver flukes. *Lymnaea* species may be either aquatic or amphibious (Fenwick, 1987: WHO, 1993). The snail species that acts as intermediate host of S. *haematobium* in the tropic are *Bulinus globosus, B. forskii* and *B. truncates* (Akogun and Okin, 1993). However, *B. senegalensis* has been reported to shed *schistosome* like cercariae (Idris and Ajanusi, 2002; Ofoezei *et al.*, 2010) S*chistosoma mansoni* is transmitted by *Biomphalaria* species in Africa by (Ekejindu *et al.,* 1999) In most areas, seasonal changes in rainfall, water level and temperature cause marked fluctuations in snail population densities and transmission rates (Fenwick, 1987; Klumpp and Chu, 1987). Most *Bulinus* species are more abundant between July and October followed by gradual decline until the month of May when density begins to rise with the beginning of rainfall. They attain their maximum size around June-September; on the other hand *Biomphalaria* shows two peaks prevalence between February and July. They attain the optimum size between September and October (Brown, 1980).

The life- cycle of any animal is the period involving the succession of one generation to the next by means of reproduction. The reproduction process of the snail is one that has some unique pattern when compared to that of other land animals. In other ways though the process is the same. In brief, mating, gestation period, egg dropping, egg hatching, maturing period and new snails are the main stages of this cycle. The age of sexual maturity is variable from 6 weeks to 5 years, depending on species of snail. Snails engage in various types of courtship rituals to attract mates. They can last mating from a couple of hours to half a day. They don't make sounds to call out to each other like many types of animals do because snails don't have the ability to hear. So they use touching as a way of courting. They may cover each other in mucus that they produce from their bodies before mating. It was believed this mucus also makes it easier for them to engage in the actual mating process. Once they have done so they will go their separate directions. Each snail has the reproduction organs of both sexes. Even though, snails need to mate, they do not fertilize themselves. However, after the mating, both snails are able to deliver a set of eggs. During the mating process both snails will conceive around 100 eggs and some of species up to 400.These eggs are extremely small and they will be deposited into the moist soil and covered. When the offspring emerge from their eggs, they immediately need to get calcium into their bodies. They are born with a shell but it is in a fragile state. The calcium will help it to quickly harden up which offers them plenty of protection. The first thing they will instinctively consume after hatching is the shell of the very egg they came from, which is rich source of calcium (Applenton *et al.,* 2009).

Figure 1. *Bulinus wrighti* collected from Kwalkwalawa Local River Sokoto

3. Biology of Schistosome Parasite

The flukes belong to the phylum: platyhelminthes; class: trematoda; subclass: digenea; family*:* Schistosomatidae; and genus: *Schistosoma*. The five most common species of *Schistosomes* infecting man and causing human schistosomiasis are:

1) *Schistosoma haematobium* (which affects 54 countries in Africa and the eastern Mediterranean, and causes urinary schistosomiasis).
2) *Schistosoma mansoni* (which is responsible for intestinal schistosomiasis in Africa).
3) *Schistosoma japonicum*
4) *Schistosoma mekongi*
5) v. *Schistosoma intercalatum-* (these three Schistosome species cause intestinal schistosomiasis in Asia and the pacific regions), other species of *Schistosoma* which parasitize man and other mammals are *Schistosoma mattheei* and *Schistosoma bevies* (John and Ojewole, 2004).

Adult female *Schistosoma* is a white or greenish, long and slime worm with a cylindrical body. It has two suckers with which the worms attach themselves to the walls of the blood vessels in which they live (John and Ojewole, 2004). It has complex tegument, a blind digestive track with mouth, esophagus and bifurcated caeca, excretory and reproductive organs. Males are smaller than the females. Females generally holds male in its gynaecophoric canal. The parasite found in blood and feeds on blood and globulins (Smyth, 1994, WHO, 2010).

A Schistosome parasite needs two hosts (a mammal and a snail) to complete its life cycle. For *S. haematobium* (urinary Schistosomiasis*)* the main definitive host is man (Abdel-hadi and Talaat, 2002) and the snail is the intermediate host (Fenwick, 1987; Klumpp and Chu, 1987). The eggs of *S. haematobium* measures about 140um long 60um wide and is characterized by an external spine while eggs of *S. mansoni* measures about 110um long by 60um wide and possess a unique lateral spine. Both eggs contain a fully matured miracidium when it is eliminated in the urine or faeces (Despommier and Karapelou 1987; WHO/TDR, 2005).

3.1. Life Cycle of the Schistosome Parasite

The life cycle of the trematodes that cause schistosomiasis in man is a typical of the other parasites of the class trematoda in that the worms are unisexual. Adult worms in humans reside in the mesenteric venules in various locations, which at times seem to be specific for each species. For instance*, Schistosoma haematobium* normally lives and mates in the veins of the urinary bladder of man, producing eggs with a terminal spine, which pass into the bladder wall and thence into the urine (WHO/TDR, 2005).

When an egg is deposited into fresh water, it hatches within a few minutes to miracidium, a highly motile larva which moves about in the water for about 24hrs with the aid of its cilia. It then seeks a suitable snail host. Once inside the soft tissues of a favorable snail host, the miracidium develops within 96hrs into a sporocyst. After 7 days, the sporocyst develops into cercariae, the final larval form. The cycle from snail penetration by the miracidium to the production of mature cercariae takes about 4 to 5 weeks for *S. mansoni*; 5 o 6 weeks for S. *haematobium;* and 7 weeks or more for S. *japonicum.* The infected snails are damaged in the process, and they die shortly after releasing the cercariae into water. The mature cercariae escape from the daughter sporocyst and enter the water, swimming vigorously by means of its bifurcated tail. A snail can shed 500-3000 cercariae of S. *haematobium* or S. *mansoni* daily when in full production, but the figure for S. *japonicum* is much less (15-160), the snails being much smaller than those infected by the other species. Cercariae do not feed and their life-span is short, up to 48 hours. They are quickly killed at 50^0c and strong sunlight, and lack of oxygen is also lethal to them (Chatterjee, 2011).

Cercariae can penetrate the skin of a definitive host within a few minutes. In doing so it sheds it tail, and once in the definitive host's tissues, it becomes a *Schistosomule*. Within 24hours, the *Schistosomule* enters the lymphatic or venous system of the host to be transported to the right heart and lungs. Some *Schistosomules* pass into the mesenteric vessels and thence to the vessels of the liver. Some may pass directly through the diaphragm to the liver and the portal vessels. Growth takes place in the liver, and paired worms may be found after about 26 days following host skin's penetration. Most worms leave the liver when they are sexually mature and have mated, and migrate to the veins of the vesical plexus (S. *haematobium*) or the mesenteric veins (*S. mansoni, S. japonicum* and *S. intercalatum*), where they begin to lay eggs. The period between skin penetration by the cercariae and egg-laying may be 30-40 days or more (Chatterjee, 2011). The mated worms move as far as possible towards the fine terminal vessels, and the female worm then leaves the male, moving to the finest vessels, where she deposits her eggs, retracting after having done so. The eggs escape from the venules into the host tissues, those of *S. haematobium* largely into the wall of the bladder but occasionally into the wall of the lower bowel, those of *S. mansoni*, *S. japonicum* and *S. intercalatum* mainly into the wall of the lower bowel. Only about 50% of the eggs produced by the adult worms are passed out in the urine or stool. The remaining half (50%) stay in the body where they can scar and damage vital organs.

The symptoms of the disease are caused by the body's reaction to the worms' eggs, and not by the worms themselves (John, 2004). Some eggs of all *Schistosoma* species are also usually found in the genital tract, liver, lungs, central nervous system, and other organs. *Schistosoma mansoni* normally lives and mates in the superior mesenteric veins of man, producing eggs with a lateral spine which pass into the wall of the large intestine and lower ileum, and thence into the faeces. *Schistosoma japonicum* normally lives and mates in the inferior mesenteric veins of man, producing eggs which pass into the bowel wall and thence into the faeces (John, 2004).

3.2. Sign and Symptoms of Schistosomiasis

Acute Schistosomiasis may occur weeks after the initial infection especially by *S. mansoni* and *S. japonicum*.
Manifestation include:

(1) Abdominal pain
(2) Cough
(3) Diarrhea
(4) Eosinophilia-extremely high eosinophil granulocyte (white blood cell) count
(5) Fever
(6) Fatigue
(7) Hepatosplenomegaly- the enlargement of the liver and spleen.

Hepatic Schistosomiasis is the second most common cause of esophageal varices for world wide.
(8) Genital sores lesion that increase vulnerability to H.I.V. infection.
(9) Skin symptoms: at the start of infection mild itching and a popular dermatitis of the feet and other parts after swimming in polluted stream containing cercariae (James *et al.,* 2006) occasionally central nervous system lesions occur: cerebral granulomatous disease may be caused by ectopic *S. japonicum* eggs in the brain, and granulomatous lesions around ectopic eggs in the spinal cord from *S. mansoni* and *S. haematobium* infection may result in a transverse myelitis with flaccid paraplegig (Freitas *et al.,* 2010) continuing infection may cause granulomatous reactions and fibrosis in the affected organs, which may result in manifestation that includes:
   - Colonic polyposis with bloody diarrhea (*S. mansoni*).
   - Portal hypertension with hematemesi and spleenomegaly (*S. mansoni, S. japonicum*).
   - Cystitis and ureteritis (*S. haematobium*) with haematuria, which can progress to bladder cancer.
   - Pulmonary hypertension (*S. mansoni, S. japonicum*, more rarely *S. haematobium*).
   - Glomerulonephritis and central nervous system lesion.

3.3. Epidemiology of Schistosomiasis

Schistosomiasis is mostly acquired when human comes into contact with water infected with cercariae. Man is infected by contact with infected water during his daily activities. The disease is acquired through the skin in most cases although, drinking contaminated water with cercariae may result to cercariae penetrating the mucous membrane and thus establishing the infection. However, swimming, bathing or working in infected water provide the most frequent chances for infection (Garba *et al.,* 2000; Agi and Okafor, 2005). Water contact activities are usually encountered more in children and others who go to streams in search of water for domestic, recreational and other purpose.

Schistosoma is a fluke that parasitize, human, cattle, dogs and other animals in various parts of tropical and sub-tropical countries including Asia, the far East Africa, South America and the West Indies. In India and Bangladesh various species of *Schistosoma* such as *S. nasalis*, *S. bovis* and *S. mansoni* have been reported. *S. nasalis* are relatively common and cause nasal granulomas in cattle and buffaloes (Southgate and Agarwal, 1990).

An estimated 200 million people are actually infected with bilharzia in 74 countries in Africa, the Middle East, South America and South East Asia, and in addition to more than 600 million people are at risk (WHO, 2002). It was estimated that 779 million people are at risk of infection by *Shistosomes* and 207 million people are infected, mostly (97%) in Africa (Steinmann *et al*., 2006). No country of the African continent is safe today from the serious public health problems that schistosomiasis causes, several African countries provide, regularly, intensities of infection in humans, associated or not with malacological surveys and *Schistosome* prevalence in snails (Steinmann *et al*., 2006).

3.4. Diagnosis of Schistosomiasis

The diagnosis that may be done include the following;

- Antibody test to check for signs of infection.
- Biopsy of tissue.
- Complete blood count (CBC) to check for signs of anemia.
- Eosinophil count to measure the number of certain white blood cells.
- Kidney function tests.
- Liver function tests.
- Stool examination to look for parasite eggs.
- Urinalysis to look for parasite eggs (Steinmann *et al*., 2006).

3.5. Treatment of Schistosomiasis

This infection is usually treated with the drug praziquantel. If the infection is severe or involves the brain, corticosteroids may be given.

4. Prevention and control

The best method for controlling both diseases such as schistosomiasis and fascioliasis is chemotherapy, using orally administered drugs for individuals with moderate or severe level of infection. The disadvantage of this approach is that it does not eliminate the infection entirely, the cost of recurrent treatment may become prohibitive and drug resistance may become a problem. A better way to tackle the problem of Schistosomiasis and Fascioliasisis is to destroy the carrier snails and remove an essential link in the life cycle of the flukes. This can be accomplished in a number of ways, including the use of many synthetic or plant Molluscicides (Singh *et al.,* 1996).
The measures for the prevention and control of schistosomiasis are stated below:

- Avoiding contact with water known to contain cercariae by: providing safe water supplies in rural areas; construction of foot bridges across infested rivers and stream, providing safe recreational bathing sites, especially for children.
- Preventing water becoming contaminated with egg through: health education and providing sanitation facilities, treating infected persons, protecting water supplies from faecal pollution by animal reservoir hosts.
- Minimizing the risk of infection from new water conservation and irrigation scheme and hydroelectric development through: treatment of workers when necessary, sitting settlement away from canals, drain domestic use, lining canals with cement, keeping them free from silt and vegetation in which snail can breed, also filling-in formally used irrigation ditches with clean soil to burry snail host and varying the water level in the system.

- Destroying snail intermediate host, mainly by: using molluscicides where this is affordable and feasible and will not harm important animals and plant life, removing vegetation from locally used water places, draining swamps, and other measures to eradicate snail habitat also by taking environmental measure to prevent seasonal flooding which result in an increase in snail number and transmission (Steinmann *et al*., 2006).

Treating water supplies by: using chlorine disinfectant where possible, storing water for 48 hours to allow time for any cercariae to die and used of the filter system at water input to prevent cercariae from entering (Cheesbrough, 1998).

4.1. Molluscicides

Molluscicides are compounds that can kill Molluscs. There are two types of molluscicides, Synthetic molluscicides (chemical) and molluscicides of plant origin (Steinmann *et al*., 2006).

4.2 Molluscicides of Plant Origin

Several countries have promoted the use of plant product due to their wide range of ideal properties, such as high target toxicity, low mammalian toxicity, low cost, solubility in water, easy bio-degradability, abundant growth in endemic areas and operator safety (Kinghorn and Evans, 1975; Marston and Hostettmann, 1985; Singh *et al.,* 1996; Singh *et al.,* 2000). Besides, a brief review of relevant literatures of other countries that shows exudates, bark and aqueous extract of leaf of olde-karabi (*Thevetia Paruvian*) kills *Lymnaea acuminata* (Lamarck) and *Indoplanorbis* exustus (Singh and Singh, 2000). Aqueous extract of neem fruits (*Azadirachta indica*) kills 100% snails, *Indoplanorbis* exustus at 4% concentration within 24hours. Similarly, aqueous extract of leaves lantana (*lantana camara*) kills 100% snails at 0.05 0.1% and 0.2% concentration within 24, 12 and 6 hours (Singh and Singh, 2005) respectively. Marson and Hostettman 1985, evaluate the molluscicidal activities N-butanol extracts and water extracts of *Nerium indicum* (Makino *Okuyama*). The latex of *Euphoribia conspicua* is toxic to adults of *Biomphalaria glabrata* (Say) (Yadav, 2000).

Molluscicidal potency of many plants *as Ambrosia maritime, Solamum nigrum, thymelaea hirsuta, Callistemon lanceolatus and Peganum harmala* were previously studied by Ahmed and Ramzy (1997), El- Ansary *et al*. (2000a, b, 2001a, b), and attributed the molluscicidal effect of these plants to the disturbance occurs in glycolytic pathways. They reported that reduction of snail compatibility for the developing parasites was due to the disturbance of hexokinase, glucose phosphate isomerase and pyruvate kinase as three glycolytic enzymes. Moreover, they declared that glycolysis is the most important metabolic pathway for infected snails which should be targeted by synthetic or plant molluscicides.

Dodonaea viscosa and *Haplophyllum tubercullatum* herbs also showed molluscicide potency through marked alteration in AMP, ADP, ATP and adenylate anergy charge of *B. alexandrina* snails (EL-Ansary *et al*., 2001a). Mantawy and Mahmoud (2002), reported that *Allium cepa* (onion) and *Allium sativum* (garlic) have molluscicidal effect through disturbance in the protein profile, glucose and glycogen content of *B. alexandrina* snails.

Dry powder of *capparis spinosa* and *Acacia arabica* plant leaves seem to have a molluscicidal potency against *Biomphalaria alexandrina* snails through disturbance in glycolytic and gluconeogenic pathways as well as protein, glucose and glycogen content (Aly *et al*., 2004; Mantawy *et al*., 2004). Truiti *et al*., (2005) stated that the aerial part of *Melochia arenosa* plant was 100% lethal to *Biomphalaria glabrata* snails at 200 ug mL^{-1} and showed LD_{50} of 143ug mL^{-1}. El-sayed (2006), stated that treatment of *Biomphalaria alexandria* snails with the dry powder of the plant aerial part *Cupressus macro–carpa* (*cupressacea*) significantly reduced pyruvate kinase, lactate dehydrogenase, hexokinase and phosphoenol pyruvate carboxykinase which are very important in metabolism of the protein and carbohydrate in both haemolymph and tissue of *Biomphalaria alexandrina* snail.

Mello-silva *et al*., (2006) considered that the latex of *Euphorbia splendens var.hislopii* is the most promising plant molluscicide because it meets the recommendation of the World Health Organization (WHO, 2002). The researchers found that 0.6mgL^{-1} of the latex of *Euphorbia splendensvar. hislopii* cause a sharp reduction in the reserved of the glycogen in the digestive gland and elevation of the protein content in the hemolymph of *B. glabrata*. *Commiphora molmol* (Myrrh) has molluscicidal effect on *Biomphalaria* snails, where the number of dead snails increased with increasing the time of exposure. One day-old egg masses were more susceptible to the ovicidal effect of *C. molmol* than the five- day old ones, hence the embryogenesis began to stop and fecundity decreased. Based on safety to man and animals, *C. molmol* is recommended as a safe molluscicide (Massoud *et al*., 2004; Al- Mathal and Fouad, 2006).

Dos santos *et al.* (2007) evaluate the latex of *Euphobia conspicua* (*Euphobiaceae*) for its molluscicidal and cercariacidal activities. It exhibited high activities against adult snails with LC_{90} values of 4.87 ug mL^{-1} and showed a lethal effect to the cercariae of *Schistosoma mansoni* at concentration of 100ug mL^{-} Tilahun *et al*., (2006) reported the molluscicidal activity of *Albizia gummifera*, *Balanite aegyptiaca*, *Hedera helix* and *Warbrugia ugandensis* against *Biomphalaria pfeifferi, Bulinus* spp. and *Physa acuta*. Benson and Olajumoke (2012) Reported that *Cymbopogon citrates* is a promising plant molluscicide candidate and deserves further studies in order to identify and characterize its molluscicidal components.

However, a good molluscicide requires the following characteristics;

a. Should be toxic to the snail at low concentration.
b. Should not be toxic to mammals, that is should neither presenting acute or chronic toxicity.
c. Should not have any adverse effects if it enters the food chain
d. It should be of low cost (Steinmann *et al*., 2006).

A number of plant species have been shown to have molluscicidal effects on vectors snail. Some plants with known molluscicidal properties, general mode of action and factors affect efficacy of molluscicide. *Securidica longpenduculata*, and *Tephrosia bracteolate* can be termed as very strong molluscides. *Euphorbia splendens*, *Atriplex stylosa*, *Jatropha curcas. Alternanthra sesselis*, *Cymbopogon citratus* and *balanite aegyptiaca*, as strong to moderate molluscicides. *Guayacum officinalis*, *Talinum triangulare* and *Chromolaena odorata*, as moderate to mild molluscicides. *Calotropis procera*, *Vernonia amygdalina*, *Nicotiana tobacum*, *Zingiber officinale* and *Ttrigonella foenum*, As weak to mild molluscicides (Steinmann *et al*., 2006).

4.3. Mode of action of plant molluscicide on snails

Investigations on mode of action plant molluscicide are done to discover which molluscan systems are affected by molluscicide. The importance of understanding the mode of action of plant molluscicides has been stressed by various investigators (WHO, 1983), in hope that less toxic, cheaper, readily available molluscicide that could be used in control of snail intermediate host of various parasitic disease could be obtained. Although effective, molluscicidal showing the activity of some compounds has not proved entirely satisfactory (Singh *et al*., 2010). In an attempt to understand the mode of action plant molluscicide that leads to snail death, investigation was made by few researchers and their findings are discussed below. Based on their mode of action, plant molluscicide can be categorized into following categories; enzyme inhibitors, neutrotransmitters inhibitors (or neutron toxin), stomach poisons, respiratory poison, contact poisons and growth inhibitors (Steinmann *et al*., 2006).

4.4 Interference with Snail Enzymes (Poison of Enzyme)

Acetylcholinestrase (AChE) is a key enzyme in the nervous system of animals, the enzyme occurred in the outer basal lamina of nerve synapse neuromuscular junction and certain other tissues. The enzyme is responsible for the termination of cholinergic impulse by hydrolysis of acetylcholine (Ache) released during synaptic transmission (Singh and Singh, 2003). The mechanism of action Ache as described by Steinmann *et al*., (2006) is that Ache is released at the myoneutral junction in organisms if an action potential is developed at the nerve ending and diffuses through the gap between the nerve and the muscle (the gap is about $100A^0$ wide). Inhibition of Ache thus permits accumulation of Ache at the synapses which concentration raises several folds in comparison to the normal levels leading first to paralysis and then eventually death of the snail (Singh and Singh, 2003). It was postulated that the inhibitor (pesticide) serves as pseudosubstrate and become attached to the active site of the enzyme. The hydrolysis of the inhibited enzyme is slow and therefore the amount of Ache becomes lesser which lead to accumulation of acetylcholine at the nerve ending (Steinmann *et al*., 2006). Achieving acute toxicity is the goal for an effective molluscicide, the early phase of metabolic activation is usually followed by a decrease and finally a cessation of enzymatic activity coincident with cell and animal death (Steinmann *et al*., 2006).

4.5. Interference with Neuron (Neurotoxins)

Abdulkarim *et al*. (2023) extensively studied the mode of action and neuropathological effect of selectron, balyuscide and ethanolic extract of anagalisarvensison the neurons of the cerebral gangliain the fresh water snail *B. alexandrina*. Electron microscopical examination of treated animals revealed severe ultra-structural alterations in the cerebral gangalia. These alterations included hyperchromatic, pyknotic or highly shrunken nucleic, extreme indentation of plasma membrane, atrophy of the perikarya of some neurons, margination of nucleoli, fragmentation or dilation of rough endoplasmic reticulum, damage of mitochondria and vacuolation and destruction of cytoplasm. The consequences of this distortion result in caseation of cellular activities such as protein synthesis. Proteins are critical chemical compounds that control everything that cell do in addition they make up the material from which cell and cell parts themselves are made. Anagalisarvensis are termed as neurotoxin because of its affinity to the ganglia which serve as the nervous center for the mollusk. The nature of the molluscan nervous system is such that any damage caused to it could result in a wide range of effects, e.g. changes in heart rate, oxygen consumption and eater uptake (Clark and Appleton, 1996). Bioactive compound that has been reported to cause muscular weakness, paralysis and death in snails was iso-pelletierine (alkaloid) isolated from the bark stem of puniocagranatum (Steinmann *et al*., 2006).

4.6. Interference with Digestive System

Saponins extracted from many source has been reported to exhibit molluscicidal properties the target sites of saponins include muscle, haemolymph, intestine and hepatopancrease (stomach poison) of fresh water snail. It inhibits the activity of Ache in the internal tissue of the snail (Steinmann *et al*., 2006). Plant extract of Euphorbia splendens, ziziphusspina-christi and ambrosia maritime were reported to induce histopathological effects of the digestive gland of *Biomphalaria alexandrina* and Bulinus truncates, the damage, included vaculations, disappearance of secretory cells from the digestive tubules as well as connective tissue between shrinkedacini and accumulation of the toxic agents in the cytoplasm of digestive and excretory cells (Bakry, 2009b). Thereby altering the permeability of the cell or interfere with regulatory or metabolic activities within them (Bakry, 2009).

4.7. Interference with growth (growth toxins)

Some molluscicde are growth inhibitors as they interfere with growth rate of the snails, this is evidenced from the investigation of Bakry, (2009a), that revealed the effect of methanolicextract of three plants Euphobiasplendens, Atriplexstylosa and Guayacumofficinalis on Biomphalariaalexandrina snail which showed considerable effect on the growth of snails by comparable decrease in shell size in the treated snails measuring, 5.22mm, 5.8mm and 6.2mm at the three week expose to LC which is lower than the controlgroup (7.4mm). Reduction in 25 growth rate also be attributed to interference of plant extract with physiological activities of the snails i.e. activities of enzymes in tissue and hemolymph of treated snails (Bakry, 2009a). Some plant extracts have influence on feeding behavior of the snail. A study conducted on jatrophagossypifolia against *B. glabrata* shows low food consumption of snail in contact with the extract from leaves and fruits this hinder the locomotive ability of snail to actively seek for food which is the fundamental for development and proliferation, and when its affected this can lead to losses with regard to establishment of snail population (WHO, 2010).

4.8. Interference with osmoregulation

Osmoregulation is a physiological process that organism uses to maintain water balance i.e to compensate for water loss, avoid excess water gain maintain proper osmotic concentration of the body fluids. Given that haemolymph of freshwater pulmonates is hyper-osmotic to the external medium and that most molluscan tissues are highly permeable, maintenance of water balance must be continuous, thus any compound interfering with the mechanisms of maintaining water balance will therefore lead to a rapid increase or decrease in body weight (Clark and Appleton, 1996). The swelling of body tissues following the application of molluscicides has been suggested as a failure of water balance control (Clark and Appleton, 1996) Labe *et al.* (2012) reported similar incidence result in development of hemorrhagic blisters over the foot sole of the snail with visible swelling of the cephalopodal mass. This resulted from damaged epithelial surfaces and consequently increases the permeability of epithelial membranes and accumulation of water in tissues, and haemorhage thus, preventing its normal osmoregulatory function. Such kind of damage may also lead to loss of haemolymph, and hence body water, however, this will cause loss rather than uptake of water. Other factors that could lead to water imbalance in snail exposed to molluscicide; are impairment of kidney function, damage to the ganglia or neuro secretion and excessive production of mucus when the snail encounters the toxin and distress syndrome (Clark and Appleton, 1996, Labe *et al.,* 2012).

5. Biology of *Balanites aegyptiaca*

5.1 B. aegyptiaca

B. aegyptiaca is a species of tree, classified as a member of either the *zygophyllacea* or the *Balanitaceae* (Abdullahi *et al*., 2011) this tree is native to much of Africa and parts of the Middle East (WHO, 2010). There are many common names for this plant (Audu *et al*., 2019). In English the fruit has been called desert date, soap berry tree or bush, throntree, Egyptian myrobalan, Egyptian balsam or Zachum oil tree, (Iwu and Maurice M. 1993), in Arabic it is known as lalob hidjihi, inteishit, and heglig (hijlij). In jieng it is called thou or thau, in Hausa it is called Aduwa, in Tamasheg, the Tuareg language taborag, in Swahili mchunju and in Amharic bedena.

Balanite aegyptiaca is found in the sahel-savannah region across Africa. It can be found in many kinds of habitat, tolerating a wide variety of soil types, from sand to heavy clay, and climatic moisture levels, from arid to sub-humid (Yves and Dechassa, 2010). It is relatively tolerant of flooding, livestock activity, and wildfire (Abdulkarim *et al*, 2023).

5.2 Scientific classification

Kingdom:	Plantae
Clade:	Tracheophytes
Clade:	Angiosperms
Clade:	Eudicots
Clade:	Rosids
Order:	Zygophyllales
Family:	Zygoplyllaceae
Genus:	*Balanites*
Species:	*aegyptiaca*
Binomial:	***Balanites aegyptiaca*** (L) Delile 1812

The *Balanites aegyptiaca* tree reaches 10m (33ft) in height with generally narrow form. The branches have long straight green spines arranged in spirals. The dark green compound leaves grow out of the base of the spines and are made up of two leaflets which are variable in size shape (Daya *et al*., 2011). The fluted trunk has greyish brown, ragged bark with yellow green patches where it is shed (Iwu and Maurice, 1993).

The inflorescence consists of bunches of a few flowers which are either sessile or are borne on short stalks. The flower buds are ovoid and covered in a short tomentose pubescence. The individual flowers are greenish yellow in colour, hermaphroditic with five petals in radial symmetry and are 8-14 millimeters 0.31-0.55in in diameter. The pedicel of the inflorescence is greyish in colour, downy and usually less than 10mm (0.39 in) in length, although 15mm (0.59 inch) has been recorded in Zambia and Zimbabwe. The ellipsoid fruit is normally less than 4cm (1.6 in) long and is green when not ripe; it ripens to a brown or pale brown fruit with a crispy skin enclosing a sticky brown or brown green pulp around a hard stone (Robert, 2016).

5.3 Benefits of Balanites aegyptiaca

The yellow, single seeded fruit is edible, but bitter (Audu *et al*., 2019), many parts of the plant are used as famine foods in African; the leaves are eaten raw or cooked, the oily seed is boiled to make it less bitter and eaten mixed with sorghurm, and the flowers can be eaten (Robert, 2016). The tree is considered valuable in Arid regions because it produces fruit even in dry times (Daya *et. al* 2011). The fruit can be fermented for alcohol beverages (Daya *et al.,* 2011). The seed cake remaining after the oil is extracted is commonly used as animal fodder in African (Daya *et al.,* 2011). The seeds of the *Balanites aegyptiaca* have Molluscicide effects on *Biomphalaria pfeifferi* (Hamidou *et al.,* 2002). Where the species coexist, African elephants consume the desert date (Kinloch and Bruce, 1972).

Desert date fruit is mixed into porridge and eaten by nursing mothers, and the oil is consumed for headache and to improve lactation (Robert 2016). Bark extracts and the fruit repel (Eshitu *et al.,* 2013) or destroy (Iwu and Manrice, 1993) freshwater snails and copepods, organisms that acts intermediary hosts of parasites including schistosoma, Bilharzia, and guinea worm. Worm infections are likewise treated with desert date, as are liver and spleen disorders. A decoction of the bark is also used as an abortifacient and an antidote for arrow poison in West African traditional medicine (Iwu and Maurice 1993).

5.4 Active Compounds in Plants

Plants are the richest source of renewable bioactive organic chemicals. The total number of plant chemicals may exceed 400,000, of these, 10,000 are secondary metabolites whose major role in the plants is reportedly defensive (Swain, 1977; Cooper and Johnson, 1984). Numerous defensive chemicals belonging to various categories (Terpenoids, Alkaloids, Glycosides, Phenols, tannins etc) that cause behavioral and physiological effects on pests have already been identified. Some important compounds are as given below:-

5.4.1 Saponins

Saponins are naturally occurring plant glycosides, which form a soapy lather with water. They consist of a sugar moiety and an Aglycone unit. Monodesmosidic saponins (sugar moiety only at position c-3) possess toxic activity where as Bidesmosidic saponins (sugar moiety both at c-3 and c-28) are inactive.

5.4.2 Alkaloids

Alkaloids are naturally occurring organic bases, which contain at least one nitrogen atom either in the hetrocyclic ring or linked to an aliphatic skeleton. They are usually colorless, crystalline non-volatile solids, slightly soluble in water but soluble in ethanol, ether and chloroform. Alkaloids have been isolated from the seeds, roots, leaves and bark of the stem. In the leaves of some species they constitute 0.5 – 8% of the dry weight. They are stored in the vacuole or in the cytoplasm in a solid form (Srivastava, 1991).

A quinolizene Alkaloid Virgilin, isolated from the leaves of *Calpurnia aurea*, kills 100% of *Biomphalaria glabrata* at 130ppm, within 48hours. Vleira and Kubo (1990), reported four quinoline Alkaloids from dichloromethane extracts of *Galipia bracteata*. Out of the quinoline caused 100% mortalities of snail *B. glabrata*.

5.4.3 Flavonoids

The term flavonoids embrace all compounds whose structure is based on flavone. Flavonoids are C_{15} compounds, which are composed of two phenolic nuclei connected by three carbon unit. Dossaji and Kubo (1980) reported that the leaves of *Polygonum senegalense* have a known flavonoid quercetin. This compound possesses significant molluscicidal activity at 10ppm, causing 100% mortality of three species of snails, *Lymnaea* and *B. glabrata* within 24 hours.

5.4.4 Diterpeneoids

They are not steam volatile and are usually obtained from plants. A new class of diterpenes which are esters of phorbol (12–deoxyphorbol,12-deoxy-16 hydroxyphorbol, ingenol, 5-deoxy-ingenol resiniferotoxin and tinyatoxin) possess highly toxic activity against pests. Cheng (1971) and Amin (1972) have recorded the molluscicidal properties of *Thea olesosa, Croton tiglium*, *Schima argenta* and *Tatropha spp*.

Adewunmi and Marquis (1980) studied the molluscicidal properties of methanolic extracts of the fruit of *J. podagrica.* The extracts of these plants were found to be very active against the snail *Bulinus globosus (*Morelet).

5.4.5 Monoterpenoids

Monoterpenoids are made up of two isoprene units and are the chief constituents of essential oils. Molluscicidal activity of thymol, carvacrol and limonene from plants of the genus lippie, has been briefly reported against *Biomphalaria glabrata* (Marston and Hostettmann, 1985).

5.4.6 Sesquiterpenes Lactones

Sesquiterpenes lactones are those compounds, which possess a sesquiterpene skeleton having an additional lactones ring. These are present essentially in the leaves and flowering head, but rarely in the stem and roots of the family compositae. Up to now 21 sesquiterpene lactones, mainly pseudoquaianolides and norsesquiterpenes have been identified in the leaves, flowers and seeds of *Ambrosia maritime*. This plant is a herbaceous weed, which is widely distributed over the Mediterranean region of Africa. There is much variation in the susceptibility of different snail species to *Ambrosia maritime*, LC_{50} doses of dried leaves of *A. maritime* against the snails *Bulinus foskalli*, *B. globosus, B. pfeifferi and Lymnaea natalensis* were 165, 149, 227 and 108ppm, respectively (Belot *et al.,* 1991).

5.4.7 Tannins

Tannins are complex phenolic compounds which can be divided into two groups:

i. The hydrolysable tannins, which are esters of Gallic acid and also glycosides of these esters and
ii. The condensed tannins, which are polymers derived from various flavonoids.

The molluscicides*,* extracts of *Krameria triandra* \and *Arctostaphylos uvaursi* are the most effective as they cause 100% kill at concentrations as low as 50ppm. The methanolic extracts of these exhibits even stronger molluscicidal activity than the aqueous extracts (Schaufelberger and Hostettmann, 1983).

Table 1. Phytochemicals present in Aqueous extract of *Balanites aegyptiaca*.

PHYTOCHEMICAL	TEST	OBSERVATION	INDICATION
Flavonoid	Ferric chloride	+ve(green colour)	Present
Tannins	Ferric chloride	+ve(blue-green colour)	Present
Saponin	Frothing test	+ve frothing	Present
Glycosides	Fehling solution	+ve(brick-red precipitate)	Present
Alkaloids	Wagners	+ve(turbidity or precipitate)	Present
Cardiac glycoside	Kellerkilleani	+ve(reddish brown colour)	Absent
Steroids	Chloroform	+ve(reddish brown colour)	Present
Volatile oils	Dilute Hcl	+ve(white precipitate)	Present
Saponin glycoside	Fehling's solution A&B	+ve(bluish green precipitate)	Present
Balsams	Alcolholic ferric chloride	+ve(dark green colour)	Present
Anthraquines	Borntrager's test	+ve(pink, red, or violet colour)	Absent

Source: Abdulkarim *et al.*, (2023)

6. Conclusion

This review explained that *B. aegyptiaca* may valuably contribute as snail molluscicide. This plant-based molluscicide is readily available, inexpensive and environmentally safer for controlling human urinary schistosomiasis. This will not only eliminate the economic burden of importing expensive synthetic molluscicides but also stimulate growth of small-scale industries in Nigeria. Furthermore, with recent researches in biotechnology, such products could be improved.

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