

Review of Using Plants as Molluscicidal, Larvicidal and Schistosomicidal in Saudi Arabia

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Abstract: Schistosomiasis, generally identified as Bilharzia, is an earliest human disease, *Schistosoma mansoni* is transmitted by the aquatic pulmonate snails of the genus *Biomphalaria*. Intestinal schistosomiasis due to infection with *Schistosoma mansoni* have been known in Saudi Arabia. Also, the urinary schistosomiasis has been reported in Saudi Arabia since 1887, absolutely certain members of the genus *Bulinus* are responsible for the transmission of urinary schistosomiasis caused by *Schistosoma haematobium* in Saudi Arabia. During the past decades numerous significant reviews on plant molluscicides have been available. Investigates on plant molluscicides has amplified in current existence in the expectation that they may confirm to be cheaper, more willingly obtainable and more associated to self-sufficient manage strategies, than the use of imported artificial molluscicides. Comparatively slight was recognized about the natural products dependable for the molluscicidal action of the plants concerned, but in the principal time a number of vigorous compounds have been secluded. Molluscicides have a record of achievement and malfunction in the management of schistosomiasis. The main objectives of selective mollusciciding are to eliminate infected snails, depress snail host population density and thus reduce snail / human infection potential, where agriculture potential is high, or in a periurban areas, molluscicides can provide the cheapest and most effective means of control. The molluscicidal properties of diverse variety of Euphorbiaceae have been expansively considered, by means of different parts of the flora and different drawing out processes in the schistosomiasis control, as well few attempts was done regarding other plants source type. Many laboratory studies were conducted to estimate the molluscicidal properties of some Saudi Arabian plants, in this review, there are precious investigational outcomes obtained as plant molluscicides from Saudi Arabia, and the results of these plant extracts as larvicidal or schistosomicidal agents, with focusing in their effect in the snails tissues to show their activity as histopathological changes were also recorded. The hopeful outcome of the molluscicidal stem extract of *Euphorbia schimperiana* will encourage us to sustain this promising natural molluscicides in the population of medical importance snails.

Key words: Schistosomiasis, *Schistosoma mansoni*, *Schistosoma haematobium*, Saudi Arabia, Plant molluscicides, Euphorbiales, larvicidal, Schistosomicidal, Histopathological changes. *Euphorbia schimperiana*

INTRODUCTION

In the latest years, many researches on plant molluscicides has improved with expectation that they may confirm to be cheaper, more willingly obtainable and more associated with self-sufficient control strategies, than the use of imported artificial molluscicides (WHO, 1993), from the time when, more 1100 plant species have been tested for their molluscicidal activity (Kloos and McCullough, 1987). Plants assessment from Kenya (Kloos *et al.*, 1987), Sudan (Ahmed *et al.*, 1984), and Nigeria (Adewunmi and Sofowora, 1980) have been reported (Marston and Hostettmann, 1991).

Several significant reviews on plant molluscicides have been available during the past decades (Kloos and McCullough, 1982 ; Marston and Hostettmann, 1985 ; Mott, 1987). Previous exploration of their probable lethal property on mammals and certain other non-mollusc groups of invertebrates should investigated before the introduction of these plants, or their parts as extracts, into the environment (Koeman, 1987). Even if there has been a great deal research on plant molluscicides, none has been used expansively in an endemic country, nor have there been dependable efforts to make sure sufficient materials of the applicant compounds for laboratory studies (WHO, 1993).

The central control of the snail vector of **schistosomiasis** may depend on the use of plants with molluscicidal properties which may be uncomplicated, economical and suitable technology (Kloos and McCullough, 1984). Research in this field started in 1930 and has developed into multidisciplinary. Up to now, more than 30 families have been screened for their molluscicidal activity (Marston and Hostettmann, 1985). in anticipation of about the past 10 years, fairly slight was identified about the natural products dependable for the

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plants molluscicidal activity but in the intervening period a number of active compounds have been isolated (Marston and Hostettmann, 1991).

In the early days of schistosomiasis control, the use of molluscicides provided the only consistent advance, but with new and more proficient drugs, morbidity control is being advocated (WHO, 1980). Nonetheless, incorporated actions concerning snail control through molluscicides and chemotherapy decrease the infection greatness and control broadcast, cost successfully in a diminutive occasion. The increasing expenses and accessibility of artificial molluscicides has, yet, led to a rising attention in the plant molluscicides studies (Sarda *et al.*, 1986).

In the schistosomiasis control, molluscicides have a record of accomplishment and breakdown. The high cost of imported synthetic compounds, along with increasing concern over the possibility of snail resistance to these compounds and their toxicity in non-target organisms, have given a new force to the revision of plant molluscicides (Duncan and Sturrock, 1987).

For the focal control of the snail vector, the using of plants with **molluscicidal properties** is an easy, cheap and suitable technology (Hostettmann, 1984). In addition, the inquiry of flora used in the conventional drugs or recorded in the ethnopharmacological journalism provides a variety of accessible molluscicides and simplify the option of discerning, cost-effectively secure snail-killing compounds (Marston and Hostettmann, 1985 ; Farnsworth *et al.*, 1987).

Without doubt, the endod, that from the berries of the Ethiopian name for the climbing plant *Phytolacca dodecandra*, is considered the supreme studied molluscicide (Lemma, 1970). The West African legume, *Milletia thonningii* is an extra lately revealed molluscicide resource. Water extracts from *M. thonningii* seeds have been exposed to be molluscicidal, cercaricidal (Squire and Whitfield, 1989), and energetic against mollusc eggs (Tang *et al.*, 1995). Another beautiful characteristic of the *M. thonningii* molluscicide is its small toxicity to fish at the molluscicidal concentrations (Perrett and Whitfield, 1996).

The expanding rate of proprietary molluscicides has stimulated a search for inexpensive, non-commercial, natural compounds from plants. This approach relies on the integration of snail control into the behavior of self-help schemes in country areas (Appleton, 1985). Many plants have been screened for their essential molluscicidal properties in an effort to discover a reasonable choice to niclosamide that is suitable for use in self-help schistosomiasis control programmes (Brackenbury and Appleton, 1998).

Current Status Of Knowledge:

The human Schistosomes are unusual in that they are dioeciously, without second intermediate host in their life cycle and also in that they grown-up in the blood vascular system of their definitive host (Schmidt and Roberts, 2000). Thus, a population of Schistosomes in the ultimate hosts may be unisexual or mixed, comprising both male and female worms (Rollinson and Simpson, 1987).

The worms responsible for the disease were finally revealed in 1851 by Theodor Bilharz, from the disease took its unique name, Bilharziasis (Schistosomiasis, 2001), it is caused by trematodes of the genus *Schistosoma* (Sturrock, 1993). The life cycle of Schistosomes includes two hosts, a definitive host (man) where the parasite undergoes sexual reproduction, and a single intermediate snail host, where there are number of asexual reproductive stages (Stewart, 1998). Schistosomiasis, generally known as bilharziasis, is a severe epidemic disease. The World Health Organization estimates that 200 – 300 million people, mainly children, are infected with Schistosomiasis (Katz *et al.*, 1986 ; Lambert *et al.*, 1991).

Al-Zanbagi (2001a, p. 57) mentioned that Intestinal schistosomiasis due to infection with *Schistosoma mansoni* have been reported in Saudi Arabia (Klimov, 1963 ; Magzoub and Kasim, 1980 ; Mahboubi *et al.*, 1988). A map published in 1956 showed several foci of intestinal schistosomiasis in Saudi Arabia (Doumenge *et al.*, 1987). *Biomphalaria pfeifferi*, the most profuse species of the snail *Biomphalaria*, acts as an intermediate host of *Schistosoma mansoni* in Saudi Arabia (Krauss, 1848 ; Al-Zanbagi, 2001b, p. 109). Al-Zanbagi (2005a, p. 11) recorded that urinary schistosomiasis has been reported in Saudi Arabia since 1887 (Islam, 1980 ; Doumenge *et al.*, 1987 ; WHO, 1993). Certain members of the genus *Bulinus* spread absolutely the *Schistosoma haematobium* in Saudi Arabia (Muller, 1781; Brown and Wright, 1980).

The schistosomiasis pathology which related to the infection is caused by the immunological and inflammatory responses of the host, and not by the direct activities of the parasites (Wakelin, 1984). The parasite must defeat the host's pre-existing resistance mechanisms before it succeeds in establishing itself within a novel host and before precise immunity has been initiated (Roitt *et al.*, 1998).

Chemotherapy is one of the mainly expensive methods for control of schistosomiasis, the most widespread endemic diseases (WHO, 1980), in addition to the development of basic sanitation and health education, are the most successful strategies to decrease the occurrence and morbidity of schistosomiasis in endemic areas, with the combined application of molluscicides against the vector snails of *schistosome* trematodes (Zani *et al.*, 1993 ; Zamith *et al.*, 1996). The use of antischistosomal drugs extends from 1912 to the present day, some specified intravenously and some particular intramuscularly. Now the only three drugs in use in a worldwide level for the

treatment of schistosomiasis are Praziquantel, Metrofonate and Oxamniquine, all are given orally and all have histories of successful usage in a variety of situations (Davis, 1993).

The contact with water harboring snail intermediate hosts, in an area where hygiene level is little and there are infected people will increase the transmission of schistosomiasis (Webbe and Jordan, 1993 ; Jordan *et al.*, 1993). Using the chemical molluscicides to reduce the number of snails and therefore, the transmission of the parasite to man is always considered one of the main methods of the disease control (Duncan, 1985). No novel molluscicides of any immense implication have been developed in the past. Bayluscide (niclosamide), the only molluscicides, is mainly used in the control programs. Even though there has been greatly investigate on plant molluscicides, none has been used up till now comprehensively in an endemic country, nor have there been reliable efforts to guarantee sufficient compounds for laboratory studies (WHO, 1993).

The evident of the Euphorbiales latex as a rapid cheap molluscicide has been proven since the last years, it is even stronger than the pesticides malathion and mexacarbate (Singh and Agrawal, 1984). The molluscicidal properties of diverse species of Euphorbiaceae have been broadly studied, using unlike parts of the plants and dissimilar extraction processes (Mott, 1987 ; Sauerwein *et al.*, 1993 ; Perrett and Whitfield, 1996 ; Liu *et al.*, 1997), each and every one species have been prospective special effects on *Biomphalaria* snails (Mendes *et al.*, 1997).

Al-Zanbagi (2003a, p. 129) recorded that from the family Euphorbiaceae, the molluscicidal action has been reported in *Bridella adoviridia* and *Cryptogonone argents* (Adewunmi and Sofowora, 1980). *Euphorbia cotonifolia* (Pereira *et al.*, 1978), *Croton macrostachys* (Daffalla and Amin, 1976), *Croton tiglium* (Yasuraoka *et al.*, 1980), *Jatropha curcas* (Medina and Woodbury, 1979) and *Euphorbia lacteal* (El-Emam *et al.*, 1982). While, Kloos and McCullough (1982) declared that *Jatropha curcas* roots proved extremely the molluscicidal achievement against *Oncomelania quadrasi* in the Philippines (Yasuraoka *et al.*, 1980), and its seeds fairly lethal against *Bulinus truncates* in Sudan (El-Kheir and El-Tohami, 1979), but it had no result against *Lymnaea* sp. in Puerto Rico (Medina and Woodbury, 1979).

Three plants from the family Euphorbiaceae in Saudi Arabia were studied to identify those parts of the plants that had molluscicidal activity. A logical progression of trials demonstrated several candidate plant molluscicides that were essentially acutely toxic to the snail vector of intestinal schistosomiasis, *Biomphalaria pfeifferi*. The LC₅₀ and LC₉₀ for different extracts from *Jatropha gluaca*, *Euphorbia helioscopia* and *Euphorbia schimperiana* have been measured (Table 1). Methanol and chloroform extracts of the plants tested were the most promising from the molluscicidal point of view with LC₅₀ values in the range of 10 - 100 ppm. The activity of the reference molluscicide, Bayluscide, was determined against *B. pfeifferi* using the same assay procedure and gave an LC₅₀ of 0.08 ppm and an LC₉₀ of 0.2 ppm (Alzanbagi, 1999 ; Alzanbagi *et al.*, 2000a).

Laboratory studies were conducted to evaluate the molluscicidal properties of these Saudi Arabian Euphorbiales (Table 2). The results showed that the methanol extract of *Euphorbia schimperiana* has a high molluscicidal potency. The activity remains stable over a wide range of temperature and pH values, in the presence of organic and inorganic substrates and after exposure of the solutions to ultraviolet radiation (Al-Zanbagi *et al.*, 2001a, p. 23).

Following the encouraging results obtained regarding the molluscicidal properties of the methanol extract of *Euphorbia schimperiana*. Laboratory experiments were carried out to determine the influence of water hardness and water pH on activity. The molluscicidal potency of the extract varies with water hardness, with maximum activity in medium hard water (150 mg/CaSo3/l). The molluscicidal activity was not significantly affected by pH 3 or pH 5, but in alkaline solution much of the activity was lost. The toxicity of the extract to a non-target organism and other snails was also determined (Table 3). The LC value solutions were efficient at disrupting embryonic development of *Biomphalaria pfeifferi* eggs *in situ* within egg masses and killing embryos in the LC₅₀ solution (56 ppm) and the LC₉₀ solution (88.5 ppm). The methanol extract of *Euphorbia schimperiana* was highly toxic to *Bulinus wrighti* and *Bulinus beccarri* in a 24 hours exposure. Also, the *Cypris* sp. is about three times more resistant than the target snail to the methanol extract (Al-Zanbagi *et al.*, 2001b, p.37 - 40). The molluscicidal activity of the dry stem methanol extract of *Euphorbia schimoeriana* was found to be due to terpenoids and phenolics with LC₅₀ of 5.7 ppp (Al-Zanbagi *et al.*, 2000b, p. 73).

The molluscicidal plant, *Euphorbia schimperiana* was collected during the four different seasons, its activity as a methanol extract of dry stems of was recorded against the snail *Biomphalaria pfeifferi* (Table 2). The high molluscicidal potency was reported on winter with LC₅₀ of 7.6 ppm. The seasonality has a remarkable effect on the molluscicidal activity of the part tested plant (Al-Zanbagi, 2001a, p. 57).

The histopathological changes resulting from exposure of *Biomphalaria pfeifferi* to the low concentrations of the methanol extract of dry stems of *Euphorbia schimperiana* were studied. The effect of the extract on various tissues (gut, digestive gland and epidermal layer) was time and concentration dependent. The results showed that the epithelium layer (Figures 1, 2, 3) is probably the primary site affected by the plant molluscicide (Al-Zanbagi *et al.*, 2002, p. 25).

Advanced experiments were done by Al-Zanbagi (2005b, p. 235 - 238) to investigate the activity of *Euphorbia schimperiana* as molluscicidal agent against *Biomphalaria alexandrina*, and as larvicidal agent

against its larval stages. The values of LC_{50} and LC_{90} of *E. schimperiana* methanol extract as molluscicidal agent were 5 ppm and 9.7 ppm respectively (Table 1). The relationship between concentrations of the extract and exposure periods required to obtain 50% and 90% miracidal mortalities were clearly investigated. Thus with increase of exposure time, the LC_{50} of *E. schimperiana* decreased from 3990 ppm after 30 minutes to 687 ppm after 180 minutes. Also the cercaricidal activity of the tested plant was recorded during the different exposure times. After 30 minutes, the LC_{50} was 656 ppm then decreased to 168.7 ppm after 180 minutes (Table 3). Also, the methanol extract of *E. schimperiana* was used to attenuate larvae of *Schistosoma mansoni*. Exposure of miracidia to concentrations ranging from 500 ppm to 3000 ppm immediately before standardized snail infection was associated with a concentration-dependent decline in cercariae emergence. The exposure of cercariae to 300 – 1000 mg/l of the tested extract before mice infection was related to clear decline in worm establishment at 55 days post-infection (Al-Zanbagi and Abuljadayel, 2005a. p. 1513).

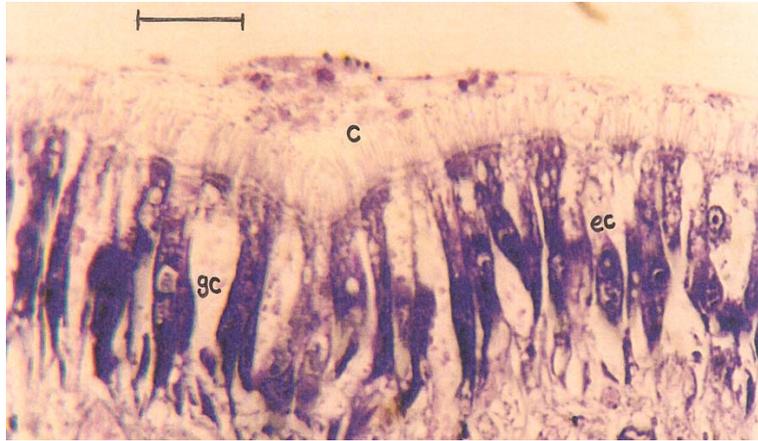


Fig. 1: Section of the epidermis layer of a normal snail showing the general epidermal cells (ec), cilia (c) and goblet cells (gc) (1000X), toluidene blue stain, the bar represents : 290 μ m

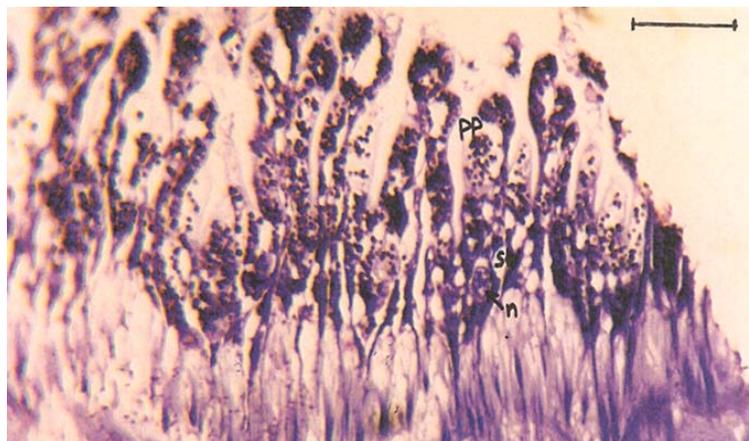


Fig. 2: Section of the epidermis layer of a snail exposed to a sublethal dose of a methanol extract of *Euphorbia schimperiana* for a 24 hours showing a partial pigmentation of this layer (pp) with some occasional nuclei (n) and small vacuoles (sv) ((1000X), toluidene blue stain, the bar represents : 290 μ m

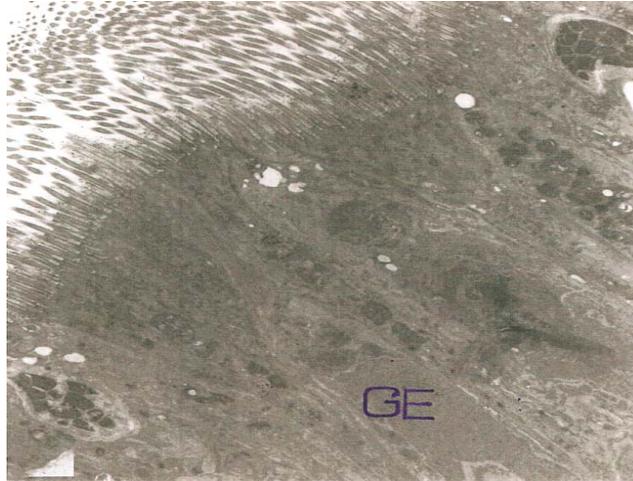


Fig. 3: Section by E. M. of the epidermis layer of a normal snail showing the general epithelial lining layer (ge), (5800X)

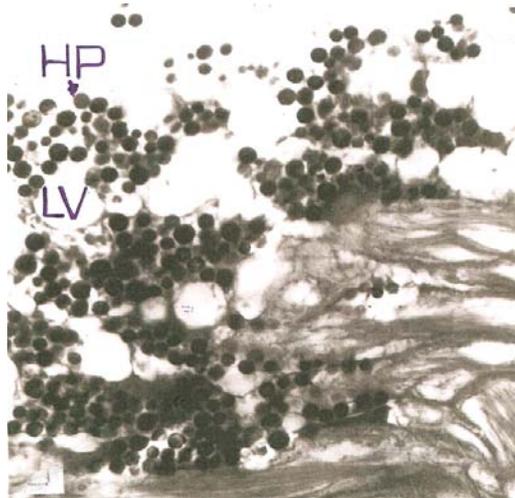


Fig. 4: Section by E. M. of the epidermis layer of a snail exposed to a lethal dose of the methanol extract of *Euphorbia schimperiana* for four hours showing the hyper pigmentation of this layer (hp) and large vacuoles (lv), (6250X)

Many experiments were done to investigate the characterization of *E. schimperiana* extract as antischistosomal drug and the morphological changes of the treated worms were noted and compared with the normal ones by Al-Zanbagi *et al.* (2005, p. 959 - 977). Reduction in worm burden, oogram changes, and reduction of eggs in tissues were the three criteria considered for the assessment of antischistosomal activity. The administration of a single dose equivalent to 15g/kg/ body weight or four consecutive daily doses resulted in a decrease of the mean total of worm burden, compared with the controls. The results of the ultrastructure with those non-treated conclude in surface topography study of elaborate confirmation that the sucker's *Schistosoma mansoni* grown in treated muscles of the treated male were reduced in size, in comparison with the untreated one.

Cercaria is similar to a small adult worm of *Schistosoma* and it is the final stage of larval development in the mollusc. Once it has reached its mammalian host, it attaches to, and then penetrates the human skin, using secretions from glands in the head region, where it sheds its tail to become a schistosomula larva. *Euphorbia schimperiana* has tested as antipenetrant agent, which showed that the presence of *E. schimperiana* methanol extract on the skin reduced the establishments of adult worms in experimental mice (Al-Zanbagi and Abuljadyal, 2005b, p. 69).

Table 1: LC₅₀ and LC₉₀ (ppm/24 h. exposure) of different extracts from several plants in Saudi Arabia

snail	Kind of plant									
	<i>Jatropha gluaca</i>		<i>Euphorbia helioscopia</i>		<i>Euphorbia schimperiana</i>		<i>Euphorbia cyparissoides</i>		<i>Azadirachta indica</i>	
	LC ₅₀	LC ₉₀	LC ₅₀	LC ₉₀	LC ₅₀	LC ₉₀	LC ₅₀	LC ₉₀	LC ₅₀	LC ₉₀
<i>B. p.</i>	(fl & c): *	(fl & c): *	(fl & c): *	(fl & c): *	(fl & c): *	(fl & c): *	N.	N.	(fl & c):	(fl & c):
	(fl & h): *	(fl & h): *	(fl & h): *	(fl & h): *	(fl & h): *	(fl & h): *	A.	A.	&	&
	(fl & m): 22	(fl & m): 30	(fl & m): 44	(fl & m): 65	(fl & m): 19	(fl & m): 24			c):	c):
	(fl & ch): *	(fl & ch): *	(fl & ch): 77	(fl & ch): 115	(fl & ch): 2	(fl & ch): 6			100	136
(fl & a): 7	(fl & a): 12	(fl & a): 91	(fl & a): 110	(fl & a): 18	(fl & a): 24					
(fl & h): *	(fl & h): *	(fl & h): *	(fl & h): *	(fl & h): 11	(fl & h): 21					
(dl & c): 73	(dl & c): 119	(dl & c): *	(dl & c): *	(dl & c): *	(dl & c): *	(dl & c):	(dl & c):	(dl & c):	(dl & c):	
(dl & h): *	(dl & h): *	(dl & h): *	(dl & h): *	(dl & h): *	(dl & h): *	&	&	&	&	
(dl & m): 85	(dl & m): *	(dl & m): 51	(dl & m): 68	(dl & m): 73	(dl & m): 96	6	12	c):	c):	
(dl & ch): 16	(dl & ch): *	(dl & ch): *	(dl & ch): *	(dl & ch): *	(dl & ch): *			30	34	
(dl & a): 103	(dl & a): 161	(dl & a): 85	(dl & a): 85	(dl & a): 35	(dl & a): 80					
(dl & h): 96	(dl & h): 47	(dl & h): *	(dl & h): *	(dl & h): 74	(dl & h): 72					
	(dl & a): 129			(dl & h): *	(dl & h): 49					
	(dl & h): 118									
(fs & c): *	(fs & c): *	(fs & c): *	(fs & c): *	(fs & c): *	(fs & c): *	N.	N.	N.	N.	
(fs & h): *	(fs & h): *	(fs & h): *	(fs & h): *	(fs & h): *	(fs & h): *	A.	A.	A.	A.	
(fs & m): 20	(fs & m): 28	(fs & m): 95	(fs & m): 95	(fs & m): 112	(fs & m): 54					
(fs & ch): 27	(fs & ch): 103	(fs & ch): 56	(fs & ch): 50	(fs & ch): 73	(fs & ch): 10					
(fs & a): 25	(fs & a): 43	(fs & a): 23	(fs & a): 23	(fs & a): 57	(fs & a): 20					
(fs & h): *	(fs & h): *	(fs & h): *	(fs & h): *	(fs & h): 32	(fs & h): 15					
(ds & c): *	(ds & c): *	(ds & c): *	(ds & c): *	(ds & c): *	(ds & c): *	(ds & c):	(ds & c):	N.	N.	
(ds & h): *	(ds & h): *	(ds & h): *	(ds & h): *	(ds & h): *	(ds & h): *	&	&	A.	A.	
(ds & m): *	(ds & m): *	(ds & m): *	(ds & m): *	(ds & m): *	(ds & m): *	10	23	c):	c):	
(ds & ch): *	(ds & ch): *	(ds & ch): *	(ds & ch): *	(ds & ch): *	(ds & ch): *					
(ds & a): *	(ds & a): *	(ds & a): *	(ds & a): *	(ds & a): *	(ds & a): *					
(ds & h): *	(ds & h): *	(ds & h): *	(ds & h): *	(ds & h): *	(ds & h): *					
		(ds & a): 69	(ds & a): 69	(ds & a): 81	(ds & a): 21					
		(ds & h): *	(ds & h): *	(ds & h): *	(ds & h): 27					
<i>B. w.</i>	N. A.	N. A.	(fl & c): 80	(fl & c): 110	(fl & c): 82	(fl & c): 106	N. A.	N. A.	N. A.	N. A.
			(fl & h): 97	(fl & h): 118	(fl & h): 73	(fl & h): 141				
			(fl & m): 11	(fl & m): 18	(fl & m): 2	(fl & m): 7				
			(fl & ch): 80	(fl & ch): 173	(fl & ch): 3	(fl & ch): 8				
			(fl & a): 9	(fl & a): 17	(fl & a): 10	(fl & a): 14				
			(fl & h): 99	(fl & h): 128	(fl & h): 18	(fl & h): 39				
<i>G. c.</i>	(fs & m): 54	(fs & m): 60	N. A.	N. A.	N. A.	N. A.	N. A.	N. A.	N. A.	N. A.
	(fs & ch): 19	(fs & ch): 35								
	(fs & a): 2	(fs & a): 4								
	(fs & h): 48	(fs & h): 178								
	(ds & m): 29	(ds & m): 68								
	(ds & ch): *	(ds & ch): *								
	(ds & a): 76	(ds & a): 135								
	(ds & h): 16	(ds & h): 30								
<i>H.d.</i>	(dl & c): *	(dl & c): *	(dl & c): *	(dl & c): *	(dl & c): *	(dl & c): *	N.	N.	N.	N.
	(dl & h): *	(dl & h): *	(dl & h): *	(dl & h): *	(dl & h): *	(dl & h): *	A.	A.	A.	A.
	(dl & m): 37	(dl & m): 80	(dl & m): *	(dl & m): *	(dl & m): *	(dl & m): *				
	(dl & ch): 95	(dl & ch): 131	(dl & ch): 86	(dl & ch): 126	(dl & ch): 100	(dl & ch): 112				
	(dl & a): 19	(dl & a): 38	(dl & a): 100	(dl & a): 126	(dl & a): 54	(dl & a): 126				
	(dl & h): 102	(dl & h): 134	(dl & h): *	(dl & h): *	(dl & h): *	(dl & h): *				
					(dl & h): 80	(dl & h): 126				

(fl): fresh leaves, (dl): dry leaves, (fs): fresh stems, (ds): dry stems, (c): cold water, (h): hot water, (m): methanol, (ch): chloroform, (a): acetone, (he): hexane (*) Asterisks, no mortality up to 100 ppm, N.A.: Not Applicable, *B. p.*: *Biomphalaria pfeifferi*, *B. w.*: *Bulinus wrighti*, *G. c.*: *Gyrulus convexiusculus*, *H.d.*: *Heliosoma duryi*

Table 2: The molluscicidal activity of the stock solution of *Euphorbia schimperiana* methanol extracts at different situations against *Biomphalaria pfeifferi* (LC₅₀ and LC₉₀ at ppm/24 h. exposure)

Different situations					
Stability at room temperature after 30 days		Stability at cold temperature after 30 days		Stability after exposure to heat temperature for one hour	
LC ₅₀	LC ₉₀	LC ₅₀	LC ₉₀	LC ₅₀	LC ₉₀
(d): 68 (al): 68 (s): 81	(d): 84 (al): 92 (s): 96	(4°C): 63 (-20°C): *	(4°C): 70 (-20°C): *	(80°C): 40	(h): 44

(d): in the dark, (al): in artificial light, (s): in sunlight, (4°C): in the fridge, (-20°C): in the freezer, (80°C): heat, * Asterisks, no mortality up to 100 ppm

Table 3: The molluscicidal activity of the dilutions of *Euphorbia schimperiana* methanol extracts at different situations (LC₅₀ and LC₉₀ at ppm/24 h. exposure)

Different situations									
Stability at sunlight		Stability at pH		Stability at organic material		Stability at inorganic material			
LC ₅₀	LC ₉₀	LC ₅₀	LC ₉₀	LC ₅₀	LC ₉₀	LC ₅₀	LC ₉₀	LC ₅₀	LC ₉₀
(c): 54 (ds): 40 (is): 37	(c): 76 (ds): 43 (is): 52	(pH5): 45 (pH9): 40	(pH5): 55 (pH9): 61	54	76	50		76	
Stability at water hardness		Stability at water pH		Activity during the four seasons		Its toxicity			
LC ₅₀	LC ₉₀	LC ₅₀	LC ₉₀	LC ₅₀	LC ₉₀	Acute oral	Acute dermal	Dermal irritation	Eye irritation
(sw): 54 (mw): 41 (hw): 50	(sw): 77 (mw): 44 (hw): 76	(3): 50 (5): 45 (8): * (10): *	(3): 76 (5): 70 (8): * (10): *	(sp): 22 (su): 34 (au): 31 (wi): 8	(sp): 31 (su): 42 (au): 40 (wi): 12	III Slightly toxic	III Non-toxic	IV Non-irritation	II moderately irritating

(c): cold, (ds): direct sunlight, (is): in shade, (pH5): acid, (pH9): alkaline, (sw): soft water, (mw): medium water, (hw): hard water, (3) water pH3, (5) water pH5, (8) water pH8, (10) water pH10, (sp): spring, (su): summer, (au): autumn, (wi): winter, * Asterisks, no mortality up to 100 ppm

In the course of a toxicological evaluation of the methanol extract of *Euphorbia schimperiana*, and prior to field application, selected acute toxicity tests were conducted in Swiss albino mice in accordance with the Organization of Economic Cooperation and Development (OECD) guidelines in order to identify any potential hazards that might arise from the use of this plant. In acute mammalian toxicity tests, acute oral, acute dermal and dermal irritation revealed that the *E. schimperiana* methanol extract was either slightly toxic or non toxic (Table 2). Only eye irritation test indicated that *E. schimperiana* is a moderately irritant, which would require eye protection for those exposed to *E. schimperiana* methanol extract (Al-Zanbagi, 2003b, p. 463).

The susceptibility of the snail *Heliosoma duryi* to the action of different extracts from dry leaves of three Saudi Arabian Euphorbiales (*Jatropha gluaca*, *Euphorbia helioscopia* and *Euphorbia schimperiana*) has been compared (Table 1). Extracts made with cold water and hot water gave negative results. From each plant, there is one extract can be considered to be superior to the others. These extracts are: the acetone extract of *Jatropha gluaca*, the chloroform extract of *E. helioscopia* and the methanol extract of *E. schimperiana*. The LC₅₀ values are ranging from 19 to 86 ppm and that of the LC₉₀ from 38 to 126 ppm. Also the acetone extract of *J. gluaca* showed the high molluscicidal activity with LC₅₀ of 19 ppm and LC₉₀ of 38 ppm (Al-Zanbagi, 2003c, p. 49 - 51).

The mortality caused to the snail *Bulinus wrighti* (the snail vector of urinary schistosomiasis) by different extracts of two species of plants belonging to the family Euphorbiaceae has been investigated. It was found that very low concentrations of fresh leaf extracts were effective in killing the snail (Table 1). The LC₅₀ of methanol and acetone extracts for *Euphorbia schimperiana* and *Euphorbia helioscopia* were 2.3 ppm and 8.9 ppm respectively (Al-Zanbagi, 2005a, p. 11).

Also Al-Zanbagi (2003a, p. 129-130) recorded the action of fresh and dry stems of *Jatropha gluaca* against the snail *Gyrulus convexiusculus* (Table 1). The high molluscicidal potency was proved by using acetone extract for fresh stems (LC₅₀ = 2.2 ppm) and hexane extract for dry stems (LC₅₀ = 16.2 ppm). In addition, she evaluated experimentally the molluscicidal activity of water extract from the leaves and stems of *Euphorbia cyparrissiodes*. The leaves were highly toxic to the snail *Biomphalaria pfeifferi*, the intermediate host of *Schistosoma mansoni* in Saudi Arabia (Table 1). The LC₅₀ and LC₉₀ were of 5.9 ppm and 11.6 ppm respectively. The toxicity was time dependent and there was a significant negative correlation between LC₅₀, LC₉₀ and the exposure time. The effect of sunlight was studied and the toxicity of the advanced extraction solutions and their active components of the best extracts were also evaluated. The molluscicidal activity was found to be restricted to pet-ether fraction and ether fraction extracts after 24 hours exposure. The three substances yielded from pet-ether extract gave negative results, while the substances obtained from ether extract which was 2A and 2B gave

the LC₅₀ of 17 ppm and 6.5 ppm respectively, but the 2C and 2D gave 0% mortality against the tested snails (Al-Zanbagi, 2003d, p. 575 - 577).

Only one study on the molluscicidal activity of Neem (*Azadirachta indica*) in Saudi Arabia was done by Al-Zanbagi (2001b, p. 109). The toxic effect of aqueous extracts of some parts of this plant was examined against the snail vector of intestinal schistosomiasis, *Biomphalaria pfeifferi* (Table 1). The dry and fresh leaves extracts gave encouraging result, the LC₅₀ and LC₉₀ values were 30 ppm and 100 ppm respectively.

Conclusion:

World Health Organization recommends the search for an excellent natural molluscicide from plant extracts in order to be effective in killing snails in low concentrations which less than 20 ppm, that only 20 plant species showed fatal concentrations under this suggested value. Also, any plant extracts that will be used as a plant molluscicide should be cheaper and more safety to the environment than the chemical molluscicides.

The *Euphorbia schimperiana* methanol extract gave encouraging results as possible molluscicides, it shows a strong effect on different species of snails as well as it is less expensive than the synthetic compounds and could be applicable in such a simple technique. Also, it shows stability under different storage conditions, as it is not extensively immersed onto neither organic nor inorganic materials. The molluscicidal concentration did not associate with that killing cercariae or miracidia and that is not understandable why. Some explanations revealed that for the differences in the active component for the different Euphorbiales species and even for the differences between the morphological parts of the same plant species.

It can be clear to declare that the fractions responsible for the *E. schimperiana* are terpenoids and phenolics, with some precautions should be kept during the application, that the methanol extract of this plant showed a little mammalian toxicity, but when used as recommended, the way will be obvious and encouraging to conduct the preliminary field trials with a strong precautions during handling this plant molluscicides.

In a parasitological study done during 2003 at Riyadh region, Saudi Arabia showed that the stool examination for slaughtered sheep revealed infection of 13.5% with *Fasciola gigantica* eggs, while adult fluke detected in the liver of these sheep was 21.9%. In the next days, *Euphorbia schimperiana* methanol extract will be examined for its activity against *Lymnaea* snails, the intermediate hosts for *Fasciola* sp. that cause a harmful effect on the cattle and sheep in Saudi Arabia, as well as against other marine snails, that play an important role in the life cycle of the fish trematodes in Red Sea. Also, the encouraging results of *E. schimperiana* as a plant molluscicide will enforce us to introduce it in the field, but we should consider the positive and negative points and we will operate these characters by using the theory of inventive problem solving "TRIZ" to get the suitable solution and good application method.

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