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MOLLUSCICIDAL ACTIVITY OF PLANT EXTRACTS OF THE EUPHORBIACEAE FAMILY ON SCHISTOSOMIASIS TRANSMITTING SNAILS: AN INTEGRATIVE REVIEW

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Abstract: The family Euphorbiaceae Juss. have several plant species which possess molluscicidal activity. Thus, the present review showed the available works on the molluscicidal activity of the used plants from that family. The searches for articles were done between December 2020 and May 2021 by five databases, and the keywords were "schistosomiasis", "Euphorbiaceae" and "molluscicide". The molluscicidal activity was evaluated in the Euphorbiaceae family by 39 articles with emphasis on the genus *Euphorbia*. The snails used in the molluscicidal tests belonged to the genera *Biomphalaria*, *Oncomelania* and *Bulinus*. Many works used the protocols of the World Health Organization (1965 and 1983) to assess the action on mollusks. It was observed that, in the tests, many works used latex (a common substance among representatives of the Euphorbiaceae family), in which latex from species such as *Euphorbia splendens* var *hislopii*, *Euphorbia milii* and *Euphorbia umbellata* demonstrated molluscicidal action. The observation time of mortality and other parameters of the mollusks varied between 24 and 96 h. In conclusion, the results found in this review can help students and researchers to identify plant species of this family that can contribute to future formulations with molluscicide activity.
Keywords: Natural products; Plants; Biological activity; Mollusks

INTRODUCTION

Schistosomiasis is a parasitic infection that affects about 250 million people in the world and occurs in tropical and subtropical countries, with little or no access to basic sanitation and drinking water (COLLEY et al., 2014; LOVERDE, 2019). Its transmission occurs through the interaction between mollusks, which are the intermediate hosts, the helminth of the genus *Schistosoma* and humans, the definitive hosts of greatest importance in the epidemiological chain of the disease (LOPES et al., 2011).

Vector snails of this endemic disease are part of the class Gastropoda. Species of the genus *Biomphalaria, Bulinus and Oncomelania* are intermediate hosts of *Schistosoma mansoni*, *Schistosoma haematobium* and *Schistosoma japonicum,* respectively (LEWIS & TUCKER, 2014; WEI et al., 2017). In Brazil, snails of the genus *Biomphalaria*, the only genus of epidemiological importance in the country, are geographically distributed in 16 of the 18 states where the disease is recorded, in addition to the Federal District (EVERTON et al., 2018).

Given the persistence of schistosomiasis transmission in various regions of the world, several measures have been proposed to solve this situation. One of them is the control of vector snails by molluscicides, substances of natural or synthetic origin used primarily to eliminate mollusks (WORLD HEALTH ORGANIZATION, 2019). Niclosamide (bayluscid) is the synthetic molluscicide currently recommended by the World Health Organization (WHO). Despite its efficacy against mollusks, this compound can be toxic to aquatic vertebrates and crustaceans and is hardly degradable in the environment (MENDES et al., 2018). Thus, there has been an increase on the interest in avoiding its use through studies on molluscicides of plant origin, which have gained importance due to their effective action and a higher rate of degradability (AFONSO-NETO et al., 2010, SINGH et al., 2010, KASHYAP et al., 2019).

Brazil, a country with a widely recognized biodiversity, has a great potential for the development of plant-based studies (LEITE et al., 2021). These are considered the focus of modern research due to the variability of the chemical and biological composition, besides they have a complex of compounds with promising activities (RIBEIRO et al., 2018). Among the biological activities derived from the secondary metabolism of plants, studies highlighted important actions such as antimicrobial, antioxidant and larvicidal on the insect *Aedes aegypti* (FONSECA et al., 2019; IRIGOYEN et al., 2020; FRAGA et al., 2021).

Family Euphorbiaceae Juss. is one of the most complex and diverse within angiosperms, with approximately 300 genera and 8,000 species described. This family occurs mainly in tropical regions, especially in Africa and America, and their species are known for their medicinal properties and presence of toxins (RAMALHO et al., 2018). The family stands out in economic terms for containing genera used in human food and folk medicine, such as *Manihot esculenta* Crantz (cassava), *Ricinus communis* L. (castor bean) and *Hevea brasiliensis* Willd. Ex. A. Juss. (rubber tree) (TRINDADE & LAMEIRA, 2014).

Several biological activities have been proven in plants of the family Euphorbiaceae, such as antibacterial (SIWE-NOUNDOU et al., 2019) and antioxidant (AIT et al., 2018). Studies investigating the molluscicidal activity of plants in this family have shown promising results (MELLO-SILVA et al., 2010; PEREIRA et al., 2017). Given the importance of these plant species in the scope of research on molluscicidal activity, this study aimed to investigate the available works on this activity that used plants of the referred family as a tool in the control of schistosomiasis.

MATERIAL AND METHODS

This article is an integrative review that was developed from the analysis of studies found in five databases: Scielo (*Scientific Electronic Library),* Portal de Periódicos CAPES, PubMed, Google Scholar and Science Direct. The search was conducted between December

2020 and May 2021. Studies that tested the molluscicidal activity of plants of the Euphorbiaceae family on snails transmitting schistosomiasis using plant extracts were selected.

The descriptors used for the searches were: “schistosomiasis”, “Euphorbiaceae” and “molluscicidal”. The articles were searched by crossing these descriptors using the Boolean operators “OR” and “AND”. As inclusion criteria, articles and scientific notes published between the years 1980 and 2020 were selected in English, Portuguese and Spanish. As exclusion criteria, monographs, dissertations, theses, papers published in events and review articles were suppressed. Studies that demonstrated molluscicidal activities in species of non-transmitting snails of schistosomiasis were also excluded and studies that used essential oils and those that tested ovicidal and cercaricidal activity. The flowchart of the methodology of this study is represented in Figure 1.

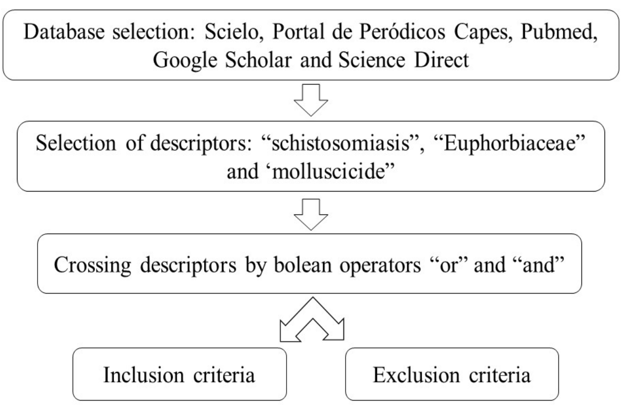

Figure 1: Flowchart of the methodology used in the study.

RESULTS

EUPHORBIACEAE FAMILY GENERA EVALUATED FOR MOLLUSCICIDAL ACTIVITY

Thirty-nine articles were found that analyzed molluscicidal activity in plants of the family Euphorbiaceae, which evaluated this action in four genera: *Euphorbia*, *Jatropha*, *Croton* and *Synadenyum*. *Euphorbia* genera was the predominant one.

The studies were organized in a table that contains data such as: the name of the plant species studied, the snails in which the molluscicidal tests were performed and the mortality observed in these mollusks (Table I). As for the plant species used for the preparation of the extracts, there was a predominance of latex, but bark, stem, leaves, fruits, roots and seeds were also used. The snails used in the molluscicidal tests belonged to the species *Biomphalaria glabrata*, *B. straminea*, *B. tenagophila*, *B. pfeifferi*, *B. alexandrina*, *Oncomelania hupensis*, *Bulinus truncatus* and *B. natalensis*.

Lethal concentrations and doses that killed 50, 90 and 100% of mollusks ranged from less than 1 to more than 100 ppm. The time of observation of mortality and other parameters of snails varied between 24 and 96 h, except for one study that evaluated the molluscicidal action during 9 h.

DISCUSSION

SPECIES OF THE EUPHORBIACEAE FAMILY AND MOLLUSCICIDAL ACTIVITIES

The studies found are focused only in the four aforementioned genres, despite the diversity of genera and species of the family Euphorbiaceae (RAMALHO et al., 2018). Genera such as *Ricinus* and *Hevea* belong to *Ricinus communis* L and *Hevea brasiliensis* Willd. Ex. A. Juss., respectively. However, they do not have any study on molluscicidal activity.

Most of the found articles studied the molluscicidal activity in plants of the genus *Euphorbia,* which is considered the largest genus of the family Euphorbiaceae, with 2,000 species, besides great diversity of varieties, distribution and morphology

(KEMBOI et al., 2020). In this genus, there was a predominance of articles that tested the molluscicidal activity *of Euphorbia splendens* Bojer ex Hook. and *Euphorbia milii* Des Moul. as well as its *hislopii* variety. According to Silva et al. (2020), these names are synonymous and any of them can be used to designate the plant popularly known as "crown-of-christ". However, to provide a better understanding, we chose this review to discuss the articles that addressed this species separately, according to the nomenclature used by the authors.

Euphorbia splendens var *hislopii* Juss was the predominant and addressed in 13 studies. Mendes et al. (1992) tested the molluscicidal properties of this plant species in a lentic habitat in Ribeirão das Neves, Minas Gerais, and observed the latex at a concentration of 5 to 12 ppm killed 100 % of B. glabrata snails after 24 hours of exposure. A similar experiment was conducted in a lotic habitat in the municipality of Paracambi, Rio de Janeiro, In this work, the latex of *E. splendens* var *hislopii* caused the death of 100% of the *B. tenagophila* snails after exposed to concentration of 100 ppm (DE VASCONCELLOS & SCHALL, 1986).

Mello-Silva et al. (2006) evaluated the physiological changes caused by the latex of *E. splendens* var *hislopii* on *B. glabrata* and found that, besides causing a mortality proportional to the administered dose, it also caused a marked reduction of the reserves of glycogen in the digestive gland and elevation of the protein content in the hemolymph of the snails. Similarly, Mello-Silva et al. (2010) observed the reduction in glycogen reserve in infected snails with *S. mansoni*, both in exposed snails and in those not exposed to latex.

Regarding *Euphorbia splendens*, we found two articles that evaluated the molluscicidal activity of *E. splendens* extract on different snail species. Bakry (2009) evaluated the effect of his *E. splendens* extract on *B. alexandrina*, and observed a remarkable reduction in the survival and growth rates of mollusks, as well as an increase in glucose content in hemolymph, and glycogen decrease in the snails' soft tissues. Another study evaluated the effect of E. splendens extracts on snails' protein content of *B. glabrata* and *B. truncatus* using electrophoresis, as the results demonstrated a considerable impact on the protein patterns of the exposed snails (ABDEL-HALEEM, 2013).

The species *E. milii* was the second most found in the searches, with five articles. Oliveira-Filho & Paumgartten (2000) tested the effects of the latex of this species on mollusk vectors of schistosomiasis (*B. glabrata* and *B. tenagophila*), in addition to non-target organisms such as *Daphnia similis* and *Danio rerio*. The authors compared these results with those of niclosamide, demonstrating that latex is more selective for vector mollusks than the molluscicide recommended by World Health Organization (WHO). Moreover, there was little toxicity to such non-target organisms.

Oliveira-Filho et al (2010) conducted a similar study on *B. glabrata* snail embryos. Although there was no death of *B. glabrata* snail embryos in a considerable number, the latex of *E. milii* interrupted the development of snails.

Pereira et al. (2017) studied the chemical composition and analyzed the effects of the latex of *Euphorbia umbellata* (Pax) Bruyns on snails of the species *B. glabrata*. The authors obtained good molluscicidal activity and low toxicity to the non-target organism used in the tests, *D. rerio* fishes. They also highlighted the importance of performing new tests with these types of organisms in order to verify the applicability of the molluscicide in the environment. In a more recent study similar to this, De Paula-Andrade et al. (2019) developed a molluscicide kit from

Plant species	Part used	Extract	Snail species	Mortality (ppm)	Time	Reference
Euphorbia tirucalli	latex	-	*B. glabrata*	$LD^{*}_{90}= 85$	48 h	Jurberg et al., 1985
Euphorbia splendens var *hislopii*	latex	-	*B. glabrata*	$LD_{90}< 0,5$	-	
	latex	-	*B. tenagophila*	$LD_{90}< 0,6$	-	De Vasconcellos & Schall, 1986
Euphorbia splendens var *hislopii*	latex	-	*B. glabrata*	-	9 h	Baptista et al., 1992
Euphorbia splendens var *hislopii*	latex	-	*B. glabrata*	-	24 h	Mendes et al., 1992
Euphorbia splendens var. *hislopii*	latex	-	*B. tenagophila*	LD_{90} between 1.02 and 1.14	-	Schall et al., 1992
Euphorbia milii	latex	-	*B. glabrata*	-	-	Zani et al., 1993
Jatropha curcas	seeds	aqueous	*B. glabrata*	$LC^{**}_{50}= 10$	48 h	
			O. hupensis	$LC_{50}= 10$	48 h	
		methanolic	*B. glabrata*	$LC_{50}= 10$	48 h	
			O. hupensis	$LC_{50}= 10$	48 h	Liu et al., 1997
Euphorbia splendens var *hislopii*	latex	-	*B. glabrata*	-	-	Mendes et al., 1997
Euphorbia milii var *hislopii*	latex	-	*B. glabrata*	-	-	Oliveira-Filho & Paumgartten, 1997
Euphorbia splendens var *hislopii*	lyophilized latex	-	*Bulinus sp.*	$LD_{90}= 0,15$	48 h	
	lyophilized latex	-	*B. glabrata*	$LD_{90}= 0,13$	48 h	
	lyophilized latex	-	*B. tenagophila*	$LD_{90}= 0,20$	48 h	
	lyophilized latex	-	*B. straminea*	$LD_{90}= 0,18$	48 h	
	natural latex	-	*B. pfeifferi*	$LD_{90}= 4$	48 h	Schall et al., 1998
Jatropha glauca	leaves and stem	methanolic	*B. pfeifferi*	$LD_{90}= 29,8$	-	
	leaves and stem	chloroform	*B. pfeifferi*	-	-	
Euphorbia helioscopia	leaves and stem	methanolic	*B. pfeifferi*	$LD_{90}= 65,5$	-	
	leaves and stem	chloroform	*B. pfeifferi*	$LD_{90}= 114,6$	-	
Euphorbia schimperiana	leaves and stem	methanolic	*B. pfeifferi*	$LD_{90}= 23,8$	-	
	leaves and stem	chloroform	*B. pfeifferi*	$LD_{90}= 5,6$	-	Al-Zanbagi et al., 2000
Jatropha elliptica	roots	ethanol	*B. glabrata*	$LD_{50}= 24,80$	24h	Dos Santos & Sant'Ana, 2000

Plant species	Part used	Extract	Snail species	Mortality (ppm)	Time	Reference
Euphorbia milii	lyophilized latex	-	*B. glabrata* *B. tenagophila* *H. duryi*	LC_{50}= 0,12 LC_{50}= 0,09 LC_{50}= 0,10	48h	Oliveira-Filho & Paumgartten, 2000
Jatropha curcas	seeds	methanolic	*B. glabrata*	LC_{100}= 25	72 h	
	seeds	methanolic	*B. truncatus*	LC_{100}= 1	72 h	
	seeds	methanolic	*B. natalensis*	LC_{100}= 1	72 h	Rug & Ruppel, 2000
Euphorbia splendens var *hislopii*	latex	-	*B. glabrata*	-	-	Schall et al., 2001
Euphorbia royleana	natural latex	-	*B. alexandrina*	-	-	
	lyophilized latex	-	*B. alexandrina*	LC_{90}= 11	-	
Euphorbia mauritanica	natural latex	-	*B. alexandrina*	LC_{90}= 60	-	
	lyophilized latex	-	*B. alexandrina*	-	-	
Jatropha curcas	-	chloroform	*B. alexandrina*	LC_{90}= 55	-	
	-	acetonitrile	*B. alexandrina*	LC_{90}= 6	-	Abdel-Hamid, 2003
Euphorbia splendens var *hislopii*	latex	-	*B. tenagophila*	LC_{90}max= 10,3	-	De Vasconcellos et al., 2003
Croton campestris	root barks	dichlorometane	*B. truncatus*	LC_{100}= 20	24 h	El Babili et al., 2006
Euphorbia splendens var. *hislopii*	latex	-	*B. glabrata*	LD_{50}= 1	24 h	Mello-Silva et al., 2006
Euphorbia conspicua	leaves	methanolic	*B. glabrata*	inactive	-	
	latex	-	*B. glabrata*	LC_{90}= 4,87	48 h	Dos Santos et al., 2007
Euphorbia splendens var *hislopii*	latex	-	*B. glabrata*	LD_{50}= 1	24 h	Mello-Silva et al., 2007
Euphorbia milii	latex	-	*B. glabrata*	-	-	
	Milin	-	*B. glabrata*	-	-	Yadav & Jagannadham, 2008
Euphorbia splendens	all superficial parts	methanolic acetone	*B. alexandrina*	LC_{90}= 27 LC_{90}= 62	24 h	Bakry, 2009
Euphorbia cornigera	roots	acetone	*B. glabrata*	LC_{50}= 0,0175	24h	Baloch et al., 2009
Croton floribundus	leaves	hexane	*B. glabrata*	LC_{90}= 85,2	-	
		ethanol	*B. glabrata*	LC_{90}= 35,2	-	

Plant species	Part used	Extract	Snail species	Mortality (ppm)	Time	Reference
	bark	methanolic	*B. glabrata*	LC_{90}= 11,5	48 h	Medina et al., 2009
Euphorbia cauducifolia	-	ethyl acetate	*B. glabrata*	LC_{50} from 1.38 to 2.67	-	Baloch et al., 2010
Euphorbia splendens var *hislopii*	latex	-	*B. glabrata*	LC_{90}= 2,3	24 h	Mello-Silva et al., 2010
Synadenium carinatum	latex	-	*B. glabrata*	LC_{100}= 0,05	24 h	Moreira et al., 2010
Euphorbia milii	latex	-	*B. glabrata*	-	96h	Oliveira-Filho et al., 2010
Synadenium grantii	leaves	alcohol	*B. glabrata*	LC_{50} = 0,04	-	Hartmann et al., 2011
Euphorbia conspicua	latex	-	*B. glabrata*	LC_{100}= 1	-	Mata et al., 2011
Euphorbia splendens var *hislopii*	latex		*B. glabrata*	LC_{50}=1		Mello-Silva et al., 2011
Euphorbia myrsinites	leaves and stem	aqueous	*B. glabrata*	LC_{50}= 15.1 (branches) and 8.9 (leaves)	24h	Patel et al., 2011
Euphorbia splendens	-	ethanol	*B. alexandrina* *B. truncatus*	LC_{90}= 50,82 LC_{90}= 40,22	48h	Abdel-Haleem, 2013
Jatropha gossypiifolia	stem	ethanol	*B. glabrata*	LC_{50}< 25	96 h	
	leaves	ethanol	*B. glabrata*	LC_{50}> 100	96 h	
	fruits	ethanol	*B. glabrata*	LC_{50}= 53,60	96 h	Pereira Filho et al., 2014
Euphorbia umbellata	latex	-	*B. glabrata*	LC_{90}= 3,69	24 h	Pereira et al., 2017
Croton floribundus	leaves	ethanol	*B. glabrata*	inactive	-	
	stem	ethanol	*B. glabrata*	inactive	48 h	Barth et al., 2018
Euphorbia milii	latex	-	*B. glabrata*	LD_{100}= 8	-	
	latex	-	*B. straminea*	LD_{100}= 8	-	
	latex	-	*B. tenagophila*	LD_{100}= 4	-	De Paula-Andrade et al., 2019
Euphorbia milii var *hislopii*	latex	-	*B. glabrata*	LC_{50}= 0,53	24 h	Alberto-Silva et al., 2020

Legend: LD* (lethal dose) and LC** (lethal concentration). LD50, LD90, LD100 and LC50, LC 90 and LC 100 represent lethal doses and concentrations that caused the death of 50, 90 and 100% of the snails. In the item "Mortality" only data related to such concentrations or doses were inserted.

Table 1: Main data of the articles found in the searches.

the lyophilized latex of *E. milii*. The results demonstrated an effective action on the snails tested, in addition to low toxicity against the non-target organism used, which was the same as that used in the previous study, suggesting that the product could be a viable alternative in combating schistosomiasis.

Two articles were found with the species *Euphorbia milii* var. *hislopii* Des Moul. Alberto-Silva et al. (2020) analyzed the influence of latex of this plant on the behavior of snails of the species *B. glabrata,* observing that there was interference in its locomotion and in the amount of spawning. In a review article conducted in 2018, Augusto & Mello-Silva showed the studies that investigated the molluscicidal activity of this species, showing that this is a promising natural molluscicide to be used in the routine of schistosomiasis control programs, as one of the reasons for its low cost.

Dos Santos et al. (2007) evaluated the molluscicidal activity of leaf extract and latex of the species *Euphorbia conspicua* N.E. Br., which showed no molluscicidal activity and were considered inactive according to the WHO classification. However, the natural latex and its irritating fractions I and II demonstrated effective action against the tested snails.

In the work of Barth et al. (2018), the ethanolic extracts of *Croton floribundus* Spreng were considered inactive against *B. glabrata*. As shown in Table I, the "inactive" results of molluscicide tests were obtained in two studies. Such inactivity can be explained by the absence of secondary metabolites that provide molluscicidal action in plants as saponins and tannins (MENDES et al., 2018).

Alberto-Silva et al. (2020) described the genus *Synadenium* Boiss as a heterotypic of *Euphorbia*. This genus was found in two articles. One of them, Moreira et al. (2010) obtained 100% mortality in *B. glabrata* snails when submitted to a concentration of 0.05 ppm of the methanolic extract of *Synadenium carinatum* Boiss. In the other article found, Hartmann et al. (2011) tested the molluscicidal activity of eight plant species, four of them of the family Euphorbiaceae. In this study, only plant that exhibited such activity was *Synadenium grantii* Hook, and the authors described this result as a pioneer for the plant in question. The molluscicidal tests used in both studies were similar, based mainly on the methodologies recommended by WHO.

Baloch et al. (2009) evaluated the molluscicidal capacity of several compounds isolated from the extracts of *Euphorbia cornigera* Boiss on the species *B. glabrata* and obtained satisfactory results. Patel et al. (2011) achieved high mortality results against the same snail when testing *Euphorbia myrsinites* L extracts. However, the authors observed that these were unstable at room temperature, which reduced their action over the days. The problem was circumvented by manufacturing a more stable product at temperature from this extract, which could be applied in the environment without serious ecological risks.

The genus *Jatropha* was the second with the highest number of species studied. It has succulent plants, shrubs and trees that have been used in human and veterinary treatments for a long time (Devappa et al. 2010). Liu et al. (1997) and Rug & Ruppel (2000) analyzed the molluscicidal action of *Jatropha curcas* L. seeds against snails of the genera *Biomphalaria, Oncomelania* and *Bulinus*. These studies were the only ones that investigated the action of seeds. In the first, the results for the two mollusk species tested were satisfactory, mainly attributing to an isolated compound of the plant, anthraquinone. In the second, several extracts were tested, and methanolic was considered the best of them. This study evaluated not only the mortality of snails but also the effects on cercariae and miracidia of *S. mansoni*.

Pereira Filho et al. (2014) evaluated the molluscicidal capacity of leaves, fruits and stems of *Jatropha gossypiifolia* L. on mollusks of the species *B. glabrata* snails. In addition to the positive results obtained regarding the mortality of snails, the fruit extract significantly influenced the feeding capacity and oviposition of the snails.

As for the *genus Croton,* its representatives are very close to the tropic's region, distributed throughout Central America, South America, Asia and North Africa (Barrera et al. 2016). El Babili et al. (2006) evaluated the action of three isolated diterpenoids of *Croton campestris* A. St-Hil. against snails *B. truncatus,* obtaining a better result with the dichlorometic extract from the root barks. Medina et al. (2009) found a positive molluscicidal action of extracts and an isolated compound of *Coton floribundus* using *B. glabrata* snails. The authors observed low toxicity of both plant species when tested in the crustacean *Artemia salina*, a saline organism widely used in toxicity assays (COSTA et al., 2008).

Al-Zanbagi et al. (2000) tested the action of extracts of *Jatropha glauca* Griseb., *Euphorbia helioscopia* L. and *Euphorbia schimperiana* Scheele on *Biomphalaria pfeifferi* snails, where methanolic and chloroform extracts showed the best mortality results. Similarly, Abdel-Hamid (2003) investigated the molluscicidal activity of *Euphorbia royleana* Boiss., *Euphorbia mauritanica* L. and *J. curcas* L. extracts and found that molluscicidal activity of the lyophilized latex of *E. royleana* was higher than that of the latex of the other species.

In general, all articles followed the methodologies of evaluation of molluscicidal activity recommended by WHO (1965 and 1983). A basic pattern was observed in the tests, which was: to prepare the extract or use the latex of the plant, test on the snail and evaluate the possible and best molluscicidal activity.

CONCLUSION

Most of the studies tested the molluscicidal action of latex (a common substance in the representatives of the family Euphorbiaceae), in which the latex of species such as *E. splendens* var *hislopii*, *E. milii* and *E. umbellata* demonstrated molluscicidal action. Some studies also tested the action of specific compounds isolated from extracts, and others, besides assessment of the mortality rate, also investigated physiological and behavioral parameters. Few studies have tested toxicity to non-target organisms, especially the most recent studies, which used species such as *D. rerio* and *A. salina.*

Most of the snails species used in the tests was *B. glabrata,* and almost all extracts used in the studies demonstrated efficient molluscicidal activity, except for two that were inactive. These results reinforce the importance of using extracts as a tool to combat schistosome transmitting snails.

It was observed that most of the obtained articles were from Brazilian authors, with the other researchers from Germany, Mali, China, France, Pakistan, India, among other countries. This fact probably occurred due to the predominance of Brazilian databases used as search tools, such as Scielo and Portal de Periódicos Capes.

The predominance of some genera and plant species as tools for molluscicidal tests attracted attention. The first explanation is the same author or authors have studied only one plant species for a long time. The second explanation is the practical results previously found in other studies that documented this activity and motivated new studies on a particular species. Finally, the unavailability of other plant species of the genus or even easy access by researchers to some species may also have contributed to these results.

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