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Potential Antischistosomal Activities of Some Egyptian Native Plants Using *Schistosoma mansoni* Worm Killing Assay

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Abstract: The present study investigated the potential antischistosomal activity of some Egyptian native plants using the *in vitro Schistosoma mansoni* worm killing assay. Praziquantel (PZQ) treated worms were used as positive control. Key findings: The bioscreening results revealed 27 extracts out of 90 different extracts from the 65 examined plant species possess reproducible *in vitro* antischistosomal activity. The LC_{50} of latex methanol extract of *Calotropis procera* was 0.30 µg/ml, while the LC_{50} of the latex water extract was 0.59 µg/ml compared to 0.21 µg/ml for PZQ. LC_{50} of latex water extract of *Calotropis procera* increased to 3.22 µg/ml. Phytochemical screening of different extracts was carried out to detect extracts major chemical constituents responsible for activity. Other species from families "Fabeace, Asparagaceae, Pittosporaceae, Balanitaceae, Zingiberaceae and Lauraceae" showed variable percentages of worm killing activities (10%-100%). Conclusion: The *C. procera* stem latex (after washing off toxic rubber materials) and flowers of *C. procera* demonstrate promising antischistosomal activity. These effects could be due to an antioxidant or anti-inflammatory activity of their content of cysteine proteases, tannins, flavonoids, sterols and terpenes.

Key words: Schistosoma mansoni · Medicinal Plants · Asclepiadaceae · Calotropis procera · Ficus decora · Worm Killing

INTRODUCTION

Schistosomiasis, a disease caused by trematode flatworms of the genus *Schistosoma*, is one of the most prevalent tropical diseases in the World [1]. Pointed out as a major neglected pathology, it is estimated that 200 million people are infected with this parasite worldwide and that approximately 779 million are at risk of contracting it Magalhães *et al.* [2]. The disease burden exceeds 70 million disability-adjusted life years [3]. Its treatment is based on the control of adult worms in infected patients, being praziquantel (PZQ) the most widely used drug. Nevertheless, the long-term application of PZQ results in decreased efficiency and appearance of resistant strains [4]. Moreover, PZQ is sometimes out of reach for some of the population living in developing countries [5]. The growing need for the development of novel and inexpensive drugs against schistosomiasis has led the scientific community to intensify the search for new products. Extracts and pure compounds obtained from plants exhibiting potential schistosomicidal properties [4-5], represent an important source for drug discovery and have produced some very effective chemotherapeutic treatments for certain parasites, e.g., antimalarial drugs [6]. The present study investigated the potential antischistosomal activity of some Egyptian native plants using the *in vitro S. mansoni* worm killing assay.

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MATERIALS AND METHODS

Chemicals: All chemicals in the present study were of analytical grade, product of Sigma-Aldrich (USA), Merck (Germany) and BDH (England).

Plant Materials: A total of 65 plants were collected locally from their natural habitats in Egypt (Zoo and El-Orman gardens); test plants were authenticated by Wafaa M. Amer, Professor of Taxonomy, Department of Botany, Faculty of Science, Cairo University, Giza, Egypt. Voucher specimens were kept in the herbarium, Medicinal Chemistry Department, Theodor Bilharz Research Institute (TBRI), Giza, Egypt.

Preparation of Extracts: Plant samples were allowed to dry at room temperature for 3 weeks before being pulverized to fine powder in a wooden mortar, 200 gm of pulverized material from each test plant was soaked in 250 ml solvent (MeOH) (Analar grade) in 500 ml round bottom flask. The mixture was left in the laboratory at room temperature for 72 hours with frequent stirring every 24 hours. Soaked samples were then filtered and the filtrate was allowed to evaporate at ambient temperature of the laboratory in a fume chamber. Extracts obtained without concentration by heat were scrapped and stored at 4°C in a refrigerator each in a labeled specimen bottle for subsequent testing using in the *in vitro* screening tests [7].

Calotropis Procera Stem Latex Extract: The latex of *C. procera* was collected from the stem near the plant buds of the plant and left to dry on glass plates under the shade at room temperature for at least 15 days then scratched from the glass plates and with the help of a mortar it was ground to small granules and extracted with water. The extract was then dried in a vacuum rotary evaporator and stored at 4°C until used [8].

Calotropis Procera Flowers Extract: Crude aqueous extract of the powdered *C. procera* flowers (100 g) was mixed with 1000 ml of distilled water in a 2 L flask and boiled for 1.5 hr. Following cooling to 40°C, the 'brew' was filtered using Whatman No.1 filter paper. The filtrate was then concentrated in a vacuum rotary evaporator and washed with chloroform and the extract was stored at 4°C until used [7].

Ficus Decora Latex Extract: The latex of *Ficus decora* (*F. decora*) was collected from the stems of the plant, dried as described for stem latex of *C. procera* and extracted with water. The resulting water extract was filtered using Whatman No. 1 filter paper and concentrated in vacuum using a rotary evaporator and then the extract was stored at 4°C for subsequent experiments.

Removal of Toxic Rubber: The toxic rubbery materials of *C. procera* & *F. decora* dry latex were washed out by extraction with aqueous methanol (85%). Then, the extract was filtrated and dried under vacuum. The dry residue obtained was washed again with boiling acetone. The clean, rubber-free acetone-insoluble portion was used in all subsequent experiments. This procedure eliminates acetone-soluble (Rubber) molecules while retaining almost all proteins [8].

Fractionation of Vitex Trifolia, Pimento Dioica and Westeria Sinensis: The air-dried powdered leaves of *V. trifolia* (500 g), *P. dioica* (300 g) and *W. sinensis (*300 g) were extracted using chloroform, methanol and chloroform respectively. The air-dried powdered leaves of the three plants were extracted at room temperature using each of the above mentioned solvents (5 x3L). The solvent was removed under reduced pressure. The obtained dry chloroform and methanol extracts for the three mentioned plants (60 g each) were suspended in H_2O (400 ml) extracted with chloroform. Two dimension paper chromatography (2D-PC) and thin layer chromatography (TLC) analysis proved that the chloroform extract for the *V. trifolia* and *W. sinensis* and the methanol extract for *P. dioica* have polyphenols. The extracts were concentrated to dryness and subjected to column chromatography on silica gel 60 (28-200 mesh) and eluted with petroleum ether (60-80°C), petroleum ether/$CHCl_3$ and then $CHCl_3$/MeOH mixtures for gradual increase of the polarity up to 100% MeOH. All separation process for the three plants was followed by Co-TLC with solvent systems: S3 (MeOH/$CHCl_3$, 2:8), S4 (EtOAc/$CHCl_3$ 7:3), S5 (MeOH/EtOAc), ($CHCl_3$/H_2O 35:32:28:7) and S6 (*n*-BuOH/MeOH/ H_2O 4:1:1) or by 2D-PC and Comp-PC using Whatman No. 1 paper with S1 [*n*-BuOH/HOAc/H2O (4:1: 5, top layer)] and S2 (15% aqueous HOAc) solvents. The individual 55 fractions were collected from the *V. trifolia* (17 fractions) and *P. dioica* (19 fractions) *and W. sinensis* (19 fractions) and were tested for their activities against *S. mansoni* worms [9].

Phytochemical Screening Tests: The different extracts of the active plants were subjected to qualitative

phytochemical investigations to identify the chemical constituents of the secondary metabolites. Tests for anthraquinones, steroids, terpenoids, flavonoids, tannins, alkaloides and saponins were carried out following standard methods [10-12].

Dose Preparations of Plants: Plant extracts were freshly prepared before used as stock solutions of 1mg/ml in methanol (Solvent) and diluted with distilled water. In addition, PZQ was freshly prepared before used as stock solutions of 1mg/ml in DMSO. Different concentrations were prepared from each of the test products and PZQ starting from 100µg/ml and decreasing to 0.1µg/ml [13].

Potential Antischistosomal Activity of Some Egyptian Native Plants Using *in Vitro* Schistosome Worm Killing: Worms were obtained from the Schistosome Biological Supply Center (SBSC), Theodor Bilharz Research Institute and collected in small petri-dishes containing RPMI 1640 media and kept in a CO_2–incubator. After preparation of different plant extract concentrations to be tested, duplicate experiment were used for each concentration/ plant extract and worms in an average number of 8-10 were placed in new clean dishes with the aid of Pasteur pipette. Residual media was decanted and fresh media (3ml/dish) with the desired concentrations of tests plant extracts were placed in each plate. Negative control using pure medium alone, medium with methanol or DMSO and positive control media containing PZQ were simultaneously used. The culture media is RPMI 1640, L-glutamine, 20% new born calf serum and antibiotics (Streptomycin + pencilline + gentamycin). After an overnight incubation in CO_2- incubator, the media containing the test plant extract was decanted and worms were placed in sterile saline and then the dishes were placed in CO_2- incubator. Saline was then removed and fresh media was added before placing dishes back into the CO_2–incubator. On the second day, worm motility was observed and the media was again changed. The dishes were left for two more days and on the 5th day, the ratio of the living to dead worms was done. At the end of observation period, (5days) worms were examined in a laminar flow hood for their viability using a stereomicroscope. For final recording of percentage worm mortality the number of dead worms relative to the total number of worms was calculated. LC_{50}'s were calculated using computerized program "Graph Pad Prism" (Pharmacologic calculation system) by a plot of the percent of worm mortality (versus living worms) against the concentration of the drug [9].

RESULTS AND DISCUSSION

In this work, the potential antischistosomal activities of several Egyptian plants were investigated primarily using *in vitro S. mansoni* worm killing techniques. Although a great deal of new drug discovery against schistosomes depends on *in vitro* and *in vivo* whole parasite screens, yet the *in vitro* screens have the advantages of allowing multiple dosing regimens and shorten the duration of the assay. The bioscreening results (Table 1) revealed that 27 extracts were found to possess reproducible *in vitro* antischistosomal activity. At the highest concentration of tested (100µg/ml) the plant extracts caused paralysis where worms appeared longer followed by death of the worms. It has been long recognized that the biological activity appears to be found in certain plants more than others. In addition, plants of the same family may possess different degrees of activities against the target organisms. The variation in activity of different extracts may be due to the different nature and amount of active components released with various solvents used in the extraction processes [14]. Our results are in agreement with those of Murti *et al*. who reported that methanolic and chloroform extracts of *C. procera* leaves caused paralysis followed by death of the *Phaeritima posthuma* adult Indian earthworm *in vitro*. The potency of the extract was found inversely proportional to the time taken for paralysis or death of worms [15].

The LC_{50} of different plant extracts (Table 2) revealed that LC_{50} of latex methanol extract of *C. procera* was 0.30 µg/ml, while the LC_{50} of latex water extract of *C. procera* was 0.59µg/ml (before removal of toxic rubber) compared to 0.21 µg/ml for PZQ. In this regard, El-Badwi *et al*. reported that the whole latex of *C. procera* has been described as a rich source of toxic compounds [16]. In addition, Singhal & Kumar suggested that, plant latex is rich in rubber like poly-isoprene fraction and predominantly exhibits pro-inflammatory effects that may account for its toxicity [17]. When the toxic rubber in latex was washed off, the latex extracts of these laticiferous plants lost toxicity. Upon preparation of water extract of *C. procera* stem latex and after removal of the toxic rubber; the extract at concentrations of 100, 50, 25, 12.5, & 6 µg/ml showed 100% mortality of the worms. The LC_{50} of latex water extract of *C. procera* increased to 3.22µg/ml, this increased in LC_{50} was due to the ineffectiveness of small concentrations tested (3 to 0.1 µg/ml). The LC_{50} of *C. procera* flower (By boiling and Decoction) extracts were comparably higher than LC_{50} of methanolic extract

Table 1: *In vitro Schistosoma mansoni* worm killing technique to test potential antischistosomal activity of some Egyptian plants.

Serial number	Plant name	Plant part	Type of plant extract	% of *S. mansoni* worm mortality (100 µg/ml)
1-	Family: Adoxaceae			
	Viburnum surfensum	Leaves	Methanol extract	0 %
2-	Family: Agavaceae			
	1- *Agave americana*	Leaves	Methanol extract	0 %
	2- *Agave decipiens*	Leaves	Methanol extract	0 %
	3- *Agave lophantha*	Leaves	Methanol extract	10 %
	4-*Dracaena beeaucarnea*	Leaves	Methanol extract	0 %
	5- *Dracaena marginata*	Leaves	Methanol extract	0 %
	6-*Furcraea elegans*	Leaves	Methanol extract	0 %
	7- *Trifasciata sp*	Leaves	Methanol extract	0 %
	8- *Yucea elephantipes*	Leaves	Methanol extract	0 %
3-	Family: Alliaceae	Leaves	Methanol extract	0 %
	Allium sativum	Leaves	Water extract	0 %
4 -	Family: Amaranthaceae			
	1-*Amarantus caudatus*	Leaves	Methanol extract	0 %
	2- *Amarantus graecizans*	Leaves	Methanol extract	0 %
	3-*Amarantus viridis*	Leaves	Methanol extract	0 %
5-	Family: Amaryllidaceae			
	Al*lium cepa*	Leaves	Oil extract	0 %
6-	Family: Anacardiaceae			
	Schinus maleia	Leaves	Methanol extract	0 %
7-	Family: Annonaceae			
	Annona cherimolia	Leaves	Methanol extract	0 %
8-	Family: Araliaceae			
	1- *Areopanax reticulatum*	Leaves	Methanol extract	0 %
	2-*Palyscias futicosa*	Leaves	Methanol extract	0 %
	3- *Scheffera arboricola*	Leaves	Methanol extract	0 %
9-	Family: Asclepiadaceae			
	1- *Asclepias sinaica*	Leaves	Methanol extract	0 %
	2-*Calotropis procera*	Latex	Methanol extract	100 %
	3- *Cynachum acutum*	Latex	Water extract	100 %
		Flowers	Boiling water ext	100 %
		Flowers	Decoction extract	50 %
		Leaves	Methanol extract	0 %
10-	Family: Asparagaceae			
	1- *Asparagus densiflorus*	Leaves	Methanol extract	10 %
	1- *Asparagus sprengeri*	Leaves	Methanol extract	17 %
	3- *Asparagus setaceus*	Leaves	Methanol extract	0 %
	4- *Furcraea selloa*	Leaves	Methanol extract	0 %
11-	Family: Asteraceae			
	1- *Calendula arvenses*	Leaves	Methanol extract	0 %
	2-- Calendula officinalis	Leaves	Methanol extract	0 %
	3-*Centaurea pallescens*	Leaves	Methanol extract	14 %
12-	Family: Balanitaceae	Fruits	Chloroform extract	0 %
	Balanatus egyptiace	Fruits	Ethyl acetate extract	10 %
13-	Family: Bignoniaceae			
	1- *Jacaranda omosaefolia*	Leaves	Methanol extract	0 %
	2- *Plumbago aurticulata*	Leaves	Methanol extract	0 %
	3-*Tecoma sessils*	Leaves	Methanol extract	0 %
	4-*Tecoma stans*	Leaves	Methanol extract	0 %
14-	Family: Biugnaceae			
	1- *Jacanda obtusifolia*	Leaves	Methanol extract	0 %
	2-*Jacaranda sparrei*	Leaves	Methanol extract	0 %
	3-*Pelmbugo varialba*	Leaves	Methanol extract	0 %
	4- *Sacaranda sp*	Leaves	Methanol extract	0 %
15-	Family: Combretaceae			
	1-*Terminallia arjuna*	Leaves	Methanol extract	0 %
	2-*Terminallia bellerica*	Leaves	Methanol extract	0 %
16-	Family: Cucurbitaceae			
	Citrullus lanatus	Seeds	Methanol extract	0 %
		Seeds	Water extract	0 %
		Seeds	Ether extract	0 %
		Seeds	Oil extract	0 %

Table 1: *Continued*

Serial number	Plant name	Plant part	Type of plant extract	% of *S. mansoni* worm mortality (100 µg/ml)
17-	Family: Cyperaceae			
	Cyperus cangnlomeratus	Leaves	Methanol extract	0 %
18-	Family: Fabeaceae			
	1- *Bauhinia variegate*	Leaves	Methanol extract	0 %
	2- *Glycyrrhiza glabra*	Leaves	Methanol extract	100 %
	3-*Porkinsonia aculata*	Leaves	Methanol extract	0 %
	4- *pterocarpus dalbergoides*	Leaves	Methanol extract	0 %
	5- *Westeria sinensis*	Leaves	Chloroform extract	40 %
19-	Family: Lamiaceae			
	Salvia affecinates	Leaves	Methanol extract	0 %
20-	Family: Lauraceae			
	Cinnamomum verum	Leaves	Ether extract	100 %
		Leaves	Methanol Successive	0 %
		Leaves	Ethyl acetate extract	100 %
		Leaves	Ethyl acetate successive	0 %
		Leaves	Methanol extract	0 %
21-	Family: Malvaceae			
	Brachycliton rupestris	Leaves	Methanol extract	0 %
22-	Family: Mimosaceae			
	Leptadenia arborea	Leaves	Methanol extract	0 %
23-	Family: Moraceae			
	Ficus decora	Latex	Methanol extract	100 %

Table 1. Cont.

Serial number	Plant name	Plant part	Type of plant extract	% of *S. mansoni* worm mortality (100 µg/ml)
24-	Family: Myrtaceae			
	1-*Pimenta dioica*	Leaves	Methanol extract	25 %
	2- *Pimenta racemosa*	Leaves	Methanol extract	0 %
25-	Family: Pinaceae			
	Pinus canariensis	Leaves	Methanol extract	0%
26-	Family: Pittosporaceae			
	Pittosporum tobira	Leaves	Methanol extract	100 %
27-	Family: Phyllanthaceae.			
	Embelica officiinalis	Leaves	Methanol extract	0 %
28-	Family: Ranunculaceae			
	Nigella sativa	Seeds	Methanol extract	0 %
		Seeds	Water extract	0 %
29-	Family: Rosaceae			
	Prunus armeniaca	Leaves	Methanol extract	0 %
		Leaves	Water extract	0 %
30-	Family: Ruscaceae			
	Sansevieria cylindrica	Leaves	Methanol extract	0 %
31-	Family: Sapindaceae			
	dodonea viscosa	Leaves	Methanol extract	0 %
32-	Family:Scrophulariaceae			
	Buddleja asiatica	Leaves	Methanol extract	0 %
33-	Family: verbaniceae			
	Vitex trifolia	Leaves	Chloroform extract	40 %
		Leaves	Methanol extract	13 %
34-	Family: Zingiberaceae			
	1-Curcuma longa	Roots	Methanol extract	10 %
		Roots	Water extract	0 %
		Roots	Ethyl acetate extract	100 %
	2-Zingiber officinale	Roots	Ether extract	10 %
		Roots	Methanol extract	100 %
		Roots	Methanol	30 %
		Fresh Roots	Methanol extract	80 %
		Dry Roots	Ethylacetate extract	100 %
		Fresh Roots	Ethylacetate extract	100 %
		Dry Roots	Ether extract	100 %
		Fresh Roots	Ether extract	0 %

Table 2: Percentage *Schistosoma mansoni* worm killing and extract LC_{50} under different concentrations of *Calotropis Procera* extracts (Latex & flowers) and Latex of *Ficus decora*.

	Concentrations (µg/ml) Percentage *S. mansoni* worm killing											
Animal groups	100	50	25	12.5	6	3	1.5	1.0	0.5	0.25	0.1	LC_{50}µg/ml
S. mansoni infected control	L	L	L	L	L	L	L	L	L	L	L	-
S.mansoni negative DMSO& Methanol	L	L	L	L	L	L	L	L	L	L	L	-
S. mansoni PZQ treated Positive control	100	100	100	100	100	100	100	100	100	41.7	0	0.21
Latex *Calotropis procera* Methanol extract	100	100	100	100	100	100	100	100	91.7	8.3	0	0.30
Latex *Calotropis procera* Water extract	100	100	100	100	100	100	100	100	8.3	0	0	0.59
Latex *Calotropis procera* Water extract without rubber	100	100	100	100	100	50	0	0	0	0	0	3.22
Flower *Calotropis procera* (boiling) extract	100	50	16.7	0	0	0	0	0	0	0	0	51.8
Flower *Calotropis procera* (Decoction) extract	50	33.3	0	0	0	0	0	0	0	0	0	134
Latex of *Ficus decora* Water after methanol extract	100	100	40	0	0	0	0	0	0	0	0	28.12

L = living

Table 3: *In vitro Schistosoma mansoni* worm killing activity of different fractions isolated from Chloroform extracts of *Vitex trifolia*, *Westeria sinensis* and methanol extract of *Pimenta dioica*.

Fraction number	% worm killing* *Vitex trifolia*	% worm killing* *Westeria sinensis*	% worm killing* *Pimenta dioica*
1	0%	0%	8 %
2	0%	0%	0 %
3	25%	0%	0 %
4	0%	10%	0 %
5	25%	0%	17 %
6	0%	0%	27 %
7	25%	0%	8 %
8	33%	0%	0 %
9	33%	10%	0 %
10	0%	0%	0 %
11	0%	10%	17 %
12	0%	0%	10 %
13	0%	0%	0 %
14	33%	0%	0 %
15	0%	0%	0 %
16	0%	0%	0 %
17	0%	0%	0 %
18	-	0%	0 %
19	-	0%	0 %

Concentration tested =100 µg/ml

Table 4: Phytochemical screening of active selected plants showing potential antischistosomal activity.

	Phytochemical tests						
Plant name	Anthra-quinones	Tannins	Flavonoids	Saponins	Steroids	Terpenoids	Alkaloids
Agave lophantha leaves	-ve	-ve	-ve	+++	-ve	+	-ve
Asparagus densiflorus leaves	-ve	-ve	-ve	+++	-ve	+	+
Asparagus spengeri leaves	-ve	-ve	-ve	+	-ve	+	+
Balanatus egyptiace fruits	-ve	-ve	-ve	+++	-ve	+	-ve
Calotropis procera flowers	-ve	+	++	-ve	+	+	-ve
Calotropis procera latex	-ve	-ve	-ve	-ve	-ve	-ve	-ve
Centaurea pallescens leaves	+	-ve	+++++	+	-ve	+	-ve
Cinnamomum verum leaves	-ve	+	-ve	-ve	-ve	++	-ve
Curcuma longa roots	-ve	+	++	++	+	++	-v
Ficus decora Latex	-ve	-ve	-ve	-ve	-ve	-ve	-ve
Glycyrrhiza glabra leaves	+	-ve	++	+++++	+	++	-ve
Pimenta dioica leaves	+	++++	++	+	++	+	-ve
Pittosporum tobira leaves	-ve	-ve	-ve	++++	-ve	+	+
Vitex trifolia leaves	-ve	-ve	+++++	+	+	+	-ve
Westeria sinensis leaves	+	-ve	++++	+	+	+	+
Zingiber officinale roots	-ve	++	+++	++	+	++	+

+++ = present in high amount, ++ = present in moderate amount, + = present in small amount, -ve =absent.

of stem latex (51.8 µ/ml g and 134 µg/ml compared to 0.30 µg/ml). Al-Qarawi *et al*. recorded anthelmintic activity of *C. procera* latex against *Haemonchus contortus* infected sheep [18]. Iqbal *et al*. testing *C. procera* flowers (Crude aqueous and crude methanolic) extracts reported promising anthelmintic activity that was shown *in vitro* causing temporary paralysis of the *Haemonchus contortus* worms [19].

Meanwhile, examining *F. decora* latex revealed antischistosmal potency with high plant concentrations (25-100 µg/ml). The LC_{50} was 28.12 µg/ml compared to 0.21 µg/ml for PZQ (Table 2). The parasiticidal activity of latex of some other *Ficus* species other than *decora* was attributed to presence of proteolytic fraction called ficin [20].

Analysis of all tested plant extracts and fractions of *pimenta dioica, Vitex trifolia and westeria sinensis* (Table 3 and 4) with respect to chemical constituents revealed the presence of phytochemicals such as phenols, tannins, flavonoids, saponins, steroids, terpenoids and alkaloids. Phytochemical screening of the extracts revealed that three species *Pimenta dioica, Vitex trifolia and westeria sinensis* were found rich in polyphenol as one of the major chemical constituents possessing potential antischistosomal activity [12]. Low concentrations of alkaloids and steroids were recorded in *C. Procera* (Flower) and *Zingiber officinale* (Table 4). In addition, moderate and high concentrations of flavonoids and saponins were recorded in *Glycyrrhiza glabra, Asparagus Sprengeri, Pittosporum tobira, Balanatus egyptiace, Agave lophantha* and *Cinnamomum verum* (Table 4). Contrary to this, none of these secondary metabolites were found in the stem latex of *C. procera* and *F. decora* pointing to possibility of presence of proteins. Jerzy *et al.* reported that the whole latex of *C. procera* (methanolic) extract of the bark is hypoglycemic and possess antiprotozoal activity [21]. Also, Stepek *et al*. testing *papaya* latex, which contains high concentrations of four distinct cysteine proteinases reported good anthelmintic activity that were shown both in vitro and in vivo in rodents causing weakening of the cuticle, blistering and rupture, the release of internal tissues leading to the death of the gastrointestinal nematode *Heligmosomoides polygyrus* worm [22]. The high antischistosomal activity of *C. procera* latex was stated to be possibly attributed to its protein content. The promising potential antischistosomal activity of *C. procera* and *F. decora* stem latex extracts recorded in this work stimulated *in vivo* testing using whole *S. mansoni* infected animals [23].

CONCLUSIONS

The *C. procera* stem latex, latex of *F. decora* (After washing off toxic rubber materials) and flowers of *C. procera* demonstrate promising antischistosomal activity. These effects could be due to an antioxidant or anti-inflammatory activity of their content of cysteine proteases, tannins, flavonoids, sterols and terpenes. The most promising water extract of *C. procera* of stem latex showing comparable activity to PZQ was recorded to possess high protein content. Therefore, it is suggested that further work should be carried out to isolate, purify and characterize the active constituents responsible for the activity of these plants with special attention to water extract of *C. procera.* In addition, additional work is encouraged to elucidate the possible mechanism of action of these extracts.

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