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Brief Communication

Molluscicidal activity of *Moringa oleifera* on *Biomphalaria glabrata*: integrated dynamics to the control of the snail host of *Schistosoma mansoni*

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A B S T R A C T

The ground seed of *Moringa oleifera* Lam., Moringaceae, has been evaluated for its molluscicidal activity against the snails *Biomphalaria glabrata*, *Physa marmorata* and *Melanoides tuberculatus*. The results show that *M. oleifera* is active against *B. glabrata* (LC_{50} 0.419 g/l; LC_{90} 1.021 g/l and *P. marmorata* (LC_{50} 0.339 g/l; LC_{90} 0.789 g/l) but has no effect against *M. tuberculatus*. The great innovation of the use of *M. oleifera*, in addition to being innocuous to humans, is the present nutritional potential for humans and animals as well as providing an ecosystemic service as water purifier.

Introduction

Schistosomiasis is a parasitic disease caused by the trematode *Schistosoma mansoni* that affects more than 200 million people, most of the cases (around 85%) occurring in African countries in the Sahara region (Chitsulo et al., 2000). In Brazil, areas with highest prevalence are in the northeastern and northern regions of the state of Minas Gerais, where the water supply in rural areas is precarious and is obtained mostly from ponds and small water reservoirs colonized by snails infected with *S. mansoni*. With the exception of the most developed areas of Brazil and some other countries as China, Dominican Republic, Philippines, Egypt, Iran, Morocco, Puerto Rico, Tunisia and Venezuela, the majority of the 76 affected countries are still incapable of adopting and implement policies to reduce the transmission of the parasite (WHO, 2011).

Molluscicides have been used as control strategies for the selective treatment of snail populations in water bodies used by humans. Niclosamide is the only commercially available molluscicide recommended by the World Health Organization for large-scale use in Schistosomiasis control programs. Ecotoxicological bioassays, however, have demonstrated severe toxicity for some soft bodied aquatic organisms in contrast to those that possess a hard exoskeleton The effect of the toxicity is the marked decline in the number of certain aquatic organisms, No toxic effect were verified to humans (Andrews et al., 1982).

Plant derived molluscicides have been proven effective particularly those of the genus Euphorbia (Baptista et al., 1994; Schall et al., 2001; Singh et al., 2005), but require handling with care since they have toxic properties to humans and aquatic organisms (Clark et al., 1997). Several initiatives for the use of plant molluscicides in the past were not promising

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or not carried on large scale programs due to the little added value that such plants possess. In the case of species from the Euphorbiaceae family, the added value, in general, was given due to its potential use as an ornamental plant, activity that arouses little interest to those populations subjected to the transmission of the disease. In order to try to change this paradigm, the molluscicidal activity of *Moringa oleifera* Lam., Moringaceae family, was tested. This is a native tree species from northwestern India, non-toxic to humans, which possesses edible leaves, fruits and roots traditionally used as food for humans and animals. According to Dahot (Dahot, 1998) its leaves may contain 27 g of protein and are rich in vitamins A and C, calcium and phosphorus. In Guatemala, several parts of this tree are used as anti-inflammatory and antispasmodic. According to folk medicine, the juice of the fresh roots, mixed with milk, may be used as diuretic, antilytic and digestive, and it may also be used in the treatment of asthma.

In Africa its seeds are used in small water treatment plants as surfactant, replacing the aluminum sulfate used as coagulant of the dissolved solids. Therefore, the plant's natural biogeographical distribution areas provide an ecosystem service as water purifier for human consumption in a large scale (Duke, 1987). In Malawi, Africa, in a water treatment plant, it has been observed that the coagulant property of aluminum is effective only at a restricted range of pH levels of the treated water, while the seeds of *M. oleifera* act without taking the pH into account (Okuda et al., 2001). Another advantage is associated with the biological treatment effect that occurs with the purification of surface waters, eliminating pathogens since most of these are physically attached to suspended particles in the water (Folkhart et al., 1993). It also presents an antibacterial activity on the cyanobacterium *Microcystis aeruginosa* (Lurling and Beekman, 2010), which is a serious global public health problem (de Figueiredo et al., 2004). In 1987, Olsen, in his work on water purification using low technology, reported the elimination of 90% of *Schistosoma mansoni* cercariae in the water. Several studies were made to verify the toxicity and cytotoxicity of *M. oleifera* on humans and domestic animals and no significant effect was observed (Nair and Varalakshmi, 2011). There are no reports of endotoxins in seed powder of this plant.

In Brazil, *M. oleifera* was introduced in the late nineteenth century with the same purpose and has adapted to the climate regime of affected areas for Schistosomiasis in the country. The use of *M. oleifera* as molluscicide may integrate human, plant and ecosystem, promoting the maintenance and sustainability of the ecosystemic structure (Turner and Daily, 2008). The "Millennium Ecosystem Assessment" ranks water and food supply, and cultural and quality of life services as precepts of the Convention on Biological Diversity (Millennium, 2005; Sukhdev, 2008) and the potential use of this plant is in accordance with their recommendations.

The aim of this study was to evaluate the molluscicidal activity of the dry seed powder of *M. oleifera* as a molluscicide on three species of fresh water snails: *Biomphalaria glabrata* (Say, 1818), *Physa marmorata* (Guilding, 1828) and *Melanoides tuberculatus* (Muller, 1774).

Materials and methods

Plant material

The seeds used in the study were collected from a 4 year's old *Moringa oleifera* Lam., Moringaceae, grown in the campus of the Fundação Oswaldo Cruz (22°52'33"S 43°14'46"W), Rio de Janeiro, Brazil. The collections were made in two different periods (April 2008, May 2010). A voucher specimen (RB498458), was deposited in the RB Herbarium of the Jardim Botânico do Rio de Janeiro/DIPEC/JBRJ, and was authenticated by Marcus Alberto Nadruz Coelho as *Moringa ovalifolia* Dinter and Berger (synonym for *M. oleifera*).

Snails

Three species of fresh water snails were used for this study: *B. glabrata, P. marmorata and M. tuberculatus* collected in Sumidouro, RJ, Brazil and maintained in the laboratory. The snails were maintained at a room temperature of 25°C in aquaria with filtered fresh water and were fed three times a week with lettuce.

Molluscicidal bioassay

The seed-lobes were grinded, the seed powder was weighed and added directly to 1000 ml of filtered water in individual beakers at seven different concentrations: 0.0 (control), 0.4, 0.6, 0.8, 1.0, 1.5 and 2.0 g/l. Six seeds of *M. oleifera* were used to obtain 1 g of seed powder. To determine the lethal concentrations (LC_{50} and LC_{90}), 140 specimens of each species were used. Ten individuals were placed in beakers for each concentration in a total of 420 snails, according to the bioassay methodology for molluscicidal plants (WHO, 1983). The snails were exposed to each solution concentration for 24 h and then transferred to water without *M. oleifera* for another 24 h.

Results and discussion

The statistical test applied to the bioassay was the Probit analysis (Finney, 1971) to define the LC. Probit analysis is the preferred statistical method used in dose-response relationships. The results demonstrated that the grinded seed of *M. oleifera* was lethal for *B. glabrata* (LC_{50} 0.419 g/l and LC_{90} 1.021 g/l) and *P. marmorata* (LC_{50} 0.339 g/l and LC_{90} 0.789 g/l) but had no effect against *M. tuberculatus* (Fig. 1).

The mechanisms of action of the product were not evaluated in the present study; however it is widely known that the seed powder of *M. oleifera* has a binding effect related to lectins which promote adhesion on particles suspended in a liquid medium (Gassenschmidt et al., 1995; Ndabigengesere et al., 1995; Okuda et al., 2001). This binding property of lectins results in a clarification and purification of the water. In the present study, the snails that died after treatment were retracted into shell and suffered hemorrhage which was the cause of death.

It can be concluded that the seed powder of *M. oleifera*, never tested before with this purpose, has molluscicidal activity, being lethal to the snails *B. glabrata* and *P. marmorata* and non-lethal to *M. tuberculatus*. Due to its non-toxic, nutritional and water purifier adjuvant characteristics, *M. oleifera* may lead to a paradigm shift within programs for snail control as well as for the implementation of enforcement strategies. This plant may be grown and used by the population, oriented by the health services, at a low cost. The characteristics of this plant are a starter for a new line of research for more specific products in the control of aquatic snails, adding other values and use for the population, being safer and with low environmental impact, associated to the protection of biodiversity of other non-target organisms.

Authorship

CLPACS designed the study, contributed in collecting the plant sample and the snails, in the running the laboratory work, data analysis and drafted the paper. TSV contributed in collecting the snails and running the laboratory work. DFB designed the study, contributed in collecting the plant sample, supervised the laboratory work and contributed to critical reading of the manuscript. All authors have read the final manuscript and approved the submission.

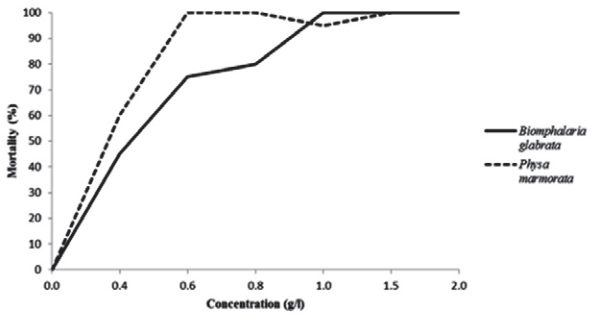

Fig. 1 - Mortality rates (%) of *Biomphalaria glabrata* and *Physa marmorata* at different concentrations of the seed powder of *Moringa oleifera*.

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REFERENCES

Andrews, P., Thyssen, J., Lorke, D., 1982. The biology and toxicology of molluscicides, Bayluscide. Pharmacol. Ther. 19, 245-295.

Baptista, D.F., Vasconcellos, M.C., Lopes, F.E., Silva, I.P., Schall, V.T., 1994. Perspectives of using *Euphorbia splendens* as a molluscicide in schistosomiasis control programs. Southeast Asian J. Trop. Med. Public Health. 25.

Chitsulo, L., Engels, D., Montresor, A., Savioli, L., 2000. The global status of schistosomiasis and its control. Acta Tropica. 77, 41-51.

Clark, T.E., Appleton, C.C., Drewes, S.E., 1997. A semi-quantitative approach to the selection of appropriate candidate plant molluscicides-a South African application. J. Ethnopharmacol. 56, 1-13.

Dahot, M.U., 1998. Vitamin contents of the flowers and seeds of *Moringa oleifera* Lam. J. Biochem. 21, 21-24.

de Figueiredo, D.R., Azeiteiro, U.M., Esteves, S.M., Goncalves, F.J., Pereira, M.J., 2004. Microcystin-producing blooms--a serious global public health issue. Ecotoxicol. Environ. Saf. 59, 151-163.

Duke, J.A., 1987. Moringaceae: horseradish-tree, drumstick-tree, sohnja, moringa, murunga-kai, mulungay, in: Benge, M.D. (Ed.), *Moringa* a multipurpose tree that purifies water. Science and Technology for Environment and Natural Resources, Boston, pp. 19-28.

Finney, D.J., 1971. Probit Analisys, 3rd ed. Cambridge University Press, New Deli.

Folkhart, G.K., Sutherland, J.P., Grant, W.D., 1993. Natural coagulants at pilot scale, in: Pickford, J. (Ed.), Water, Environment and Management: Proceedings of the 18th WEDC Conference, Aug 30-Sept 3 1992, Kathmandu, Nepal. Loughborough University Press, University Press, pp. 51-54.

Gassenschmidt, U., Jany, K.D., Tauscher, B., Niebergall, H., 1995. Isolation and characterization of a flocculating protein from *Moringa oleifera* Lam. Biochim. Biophys. Acta. 1243, 477-481.

Lurling, M., Beekman, W., 2010. Anti-cyanobacterial activity of *Moringa oleifera* seeds. J. Appl. Phycol. 22, 503-510.

Millennium, 2005. Synthesis Reports. Millennium Ecosystem Assessment, www.unep.org/maweb/en/Synthesis.aspx.

Nair, S., Varalakshmi, K.N., 2011. Anticancer, cytotoxic potential of *Moringa oleifera* extracts on HeLa cell line. J. Nat. Pharm. 2, 138-142.

Ndabigengesere, A., Narasiah, K.S., Talbot, B.G., 1995. Active agents and mechanism of coagulation of turbid waters using *Moringa oleifera*. Water Res. 29, 703-710.

Okuda, T., Baes, A.U., Nishijima, W., Okada, M., 2001. Isolation and characterization of coagulant extracted from *Moringa oleifera* seed by salt solution. Water Res. 35, 405-410.

Schall, V.T., Vasconcellos, M.C., Rocha, R.S., Souza, C.P., Mendes, N.M., 2001. The control of the schistosome-transmitting snail *Biomphalaria glabrata* by the plant Molluscicide *Euphorbia splendens* var. *hislopii* (syn milli Des. Moul): a longitudinal field study in an endemic area in Brazil. Acta Tropica. 79, 165-170.

Singh, S.K., Yadav, R.P., Tiwari, S., Singh, A., 2005. Toxic effect of stem bark and leaf of Euphorbia hirta plant against freshwater vector snail *Lymnaea acuminata*. Chemosphere. 59, 263-270.

Sukhdev, P., 2008. The Economics of Ecosystems and Biodiversity. Interim Report of the Convention on Biological Diversity. European Communities, Cambridge, United Kingdom.

Turner, R.K., Daily, G.C., 2008. The ecosystem services framework and natural capital conservation. Environ Resour Econ. 39, 25-35.

WHO, 1983. Report of scientific working group on plant molluscicide and guidelines for evaluation of plant molluscicide. World Heath Organization Geneva.

WHO, 2011. Weekly epidemiological record n° 9. World Heath Organization, pp. 73-80.