

13

Battling bilharzia: Swaziland



GENERAL INFORMATION

- ◆ **Implementing institution**
Swaziland Institute for Research in Traditional Medicine,
Medicinal and Indigenous Food Plants (SIREMIFOP),
University of Swaziland
- ◆ **Head**
Professor Lydia Makhubu
- ◆ **Details of institution**
Address: Swaziland Institute for Research in Traditional
Medicine, Medicinal and Indigenous Food Plants,
University of Swaziland, Private Bag 4, Kwaluseni, Swaziland
Tel.: (+268) 518 6816
Fax: (+268) 518 5605
E-mail: sharon@uniswacc.uniswa.sz
Web site: www.uniswa.sz/centinst/siremifop/
- ◆ **Implementation period**
1978 to date
- ◆ **Costs**
Funds have been provided by the University of Swaziland
(US\$65,000), the United States Agency for International
Development (USAID, US\$36,000) and the World Health
Organization (WHO, US\$3,600).

SUMMARY

Bilharzia, or schistosomiasis, is a disease caused by parasitic blood flukes of the genus *Schistosoma*. Throughout the tropics and subtropics, up to 300 million people are infected, making bilharzia second only to malaria in terms of its socio-economic and public health importance in these areas.

A collaborative project involving the Swaziland Institute for Research in Traditional Medicine, Medicinal and Indigenous Food Plants (SIREMIFOP), the Bilharzia Unit of the Ministry of Health and Social Welfare, the School of Environmental Sciences and Development of the University of Potchefstroom, South Africa and Legesse Wolde-Yohannes, an endod specialist from Ethiopia, together with rural development centres in Ntfontjeni Inkhundla and Manzini North Inkhundla has been initiated. It is a community outreach project involving the cultivation of endod (*Phytolacca dodecandra*) for the control of bilharzia in rural communities where the disease is endemic. The two rural communities participate in the cultivation of endod, prepare a powder from the harvest of berries, and apply given doses of the powder to ponds infested with bilharzia-transmitting snails. The outreach programme has also been extended to field workers, who are given the task of controlling parasitic diseases in the country and of providing technical know-how on the epidemiology of diseases.

Throughout the project, research findings have been applied at the grass-roots level using simple, unsophisticated technology for the benefit of local communities.

BACKGROUND AND JUSTIFICATION

Bilharzia, or schistosomiasis, is a parasitic disease that affects some 200 to 300 million people in the tropics and subtropics. Among human parasitic diseases, schistosomiasis ranks second only to malaria in terms of socio-economic and public health importance in the 74 countries where it is endemic.

Among these countries is Swaziland, where the disease is common in rural communities. Indeed, it is now known that the disease is increasing in both distribution and intensity, partly owing to the creation of new water resources to meet the increasing demand for agricultural irrigation.

The disease is caused by trematodes, also known as flatworms or blood flukes, of the genus *Schistosoma*. Several *Schistosoma* species infect humans, the most important of which are *S. haematobium*, *S. japonicum*, *S. mansoni* and *S. mekongi*. In southern Africa, *S. matheei*, typically a parasite of cattle, goats and sheep, also sometimes infects humans. Three species are prevalent in Swaziland: *S. mansoni*, which causes intestinal schistosomiasis, *S. haematobium*, which causes urinary schistosomiasis, and *S. matheei*.

To complete their life cycle, the *Schistosoma* parasites require an intermediate host, which is typically an aquatic snail. In Swaziland, the intermediate snail host for *S. haematobium* is *Bulinus (Physopsis) africanus*, which is common in the midlevelled (around 675 metres above sea level) and lowveld (around 250 metres above sea level) but is found only rarely in the highveld (1,400 metres above sea level). The intermediate snail host for *S. mansoni* is *Biomphalaria pfeifferi*, which is prevalent in the lowveld. The *Lymnaea natalensis* snail, an intermediate host for the cattle liver fluke, was also included in the project because of the cultural and commercial importance of cattle in Swaziland.

After developing and reproducing in the intermediate snail host, larval stages known as cercariae are released into the water. These microscopic, free-swimming larvae actively seek out a human host and burrow through the skin. They then migrate to the liver where they

develop to maturity. Once mature, they move to the blood vessels of the intestines or the urinary bladder, causing intestinal and urinary schistosomiasis, respectively. The disease symptoms depend on the species of parasite involved and may include diarrhoea, fatigue and fever as well as damage to the bladder, liver and spleen. Heavy infections can also be fatal and have been implicated as a cause of cancer.

Worldwide, schistosomiasis control has been based on a combination of several methods, including the treatment of infected people with such synthetic drugs as metrifonate, oxamniquine and praziquantel; educating people in hygienic preventive measures that can be taken against the disease; and the use of molluscicides to kill the intermediate snail hosts and thus break the parasite's life cycle. The use of molluscicides for the control of the disease is also important as, unlike the use of synthetic drugs, it prevents the reinfection of people after treatment.

Figure 1 |
Endod berries, the
source of the molluscicidal
saponins.



One commonly used molluscicide is the synthetic bayluscicide. However, several plant-derived molluscicides have also proven useful. Naturally occurring molluscicides have been obtained from such species as *Phytolacca dodecandra* (endod, family Phytolaccaceae), *Swartzia madagascariensis* (a tree in the family Caesalpinaceae), *Tetrapleura tetraptera* (family Fabaceae), and *Urginea epigea* (family Hyacinthaceae). Of these, *P. dodecandra* has been shown to be the most effective and is widely used in other African countries such as Ethiopia. The molluscicidal properties of endod result from the saponin content of the berries (fig. 1). Previously, the University of Swaziland, in collaboration with other institutions from Canada, Ethiopia, the United States, Zambia and Zimbabwe, investigated some aspects of the use of endod. The current case study highlights the application of the findings of these previous studies.

DESCRIPTION

The project covered four main areas:

- a workshop on the epidemiology of schistosomiasis;
- the mobilization of rural communities;
- the establishment of gardens and fields for the cultivation of endod, and
- the establishment of a snail laboratory for testing the potency of endod berries.

Early in the implementation of the

project, SIREMIFOP organized a workshop on the epidemiology of schistosomiasis as part of the institute's outreach programme. Participants were mostly field workers from the Ministry of Health and Social Welfare with the task of controlling parasitic diseases in the country. Other participants were from the Red Cross, the University of Potchefstroom, South Africa, and the World Health Organization (WHO).

Rural communities were mobilized by speaking with patients when they reported to Ministry of Health and Social Welfare clinics for treatment. Such education of rural communities led to their involvement in the project. Research findings on the agronomy and molluscicidal properties of endod, including variety trials and comparisons of endod crops grown in different regions of the country, have been shared with communities where the disease is endemic. This, in turn, has led community leaders to donate land for endod gardens (fig. 2). It has also been demonstrated that the cultivation of endod can be combined with the production of subsistence vegetables, making it more acceptable to the local communities, some of which have formed cooperative groups combining these two practices.

Local communities are also responsible for converting the endod berries into powdered products that can be easily applied as molluscicides (fig. 3). It has been demonstrated that the use of such powders is feasible in rural communities and costs little. It is also safe and environ-



Figure 2 |
Growing endod on land donated to the local community.



Figure 3 |
Preparing a solution of endod extract prior to treating a snail-infested pond.

mentally friendly. Fish eggs, for example, survive in ponds treated with endod berries.

To test the effectiveness of different preparations of endod berries, a snail laboratory was established. Cultures of three species of snail — the intermediate hosts of bilharzia in Swaziland — were maintained.

Field trials carried out in different parts of the country and using different endod types from Ethiopia (types 3, 17 and 44) showed that berry yields were highest at Luyengo in the middleveld, and that type 44 outyielded types 3 and 17 (table 1).

In other trials, endod type 44 produced significantly greater yields of berries than accessions from Nigeria and Zambia but was comparable with an accession from Zimbabwe in that, although it yielded less per plant, more plants actually produced berries (table 2). Indeed, there are reports of endod being used effectively to control bilharzia-carrying snails in both Zambia and Zimbabwe.

However, despite type 44 performing well in these comparative trials, yields obtained in Swaziland are only one quar-

Table 1 | Yields of endod berries in field trials at three different locations (lowveld, middleveld and highveld) in Swaziland.

YIELD (DRY WEIGHT OF BERRIES)						
LOCATION	TYPE 3		TYPE 17		TYPE 44	
	AVERAGE YIELD (g per plant)	ESTIMATED YIELD (kg per ha)	AVERAGE YIELD (g per plant)	ESTIMATED YIELD (kg per ha)	AVERAGE YIELD (g per plant)	ESTIMATED YIELD (kg per ha)
Big Bend (lowveld)	120	100	211	176	241	201
Luyengo (middleveld)	276	230	284	237	373	311
Motshane (highveld)	63	53	92	77	82	68

Table 2 | Yield comparison of endod accessions from Ethiopia (type 44), Nigeria, Zambia and Zimbabwe.

SOURCE OF ENDOD	DRY YIELD PER PLANT (G)	PERCENTAGE OF PLANTS YIELDING BERRIES
Type 44 (Ethiopia)	104	67
Nigeria	30	33
Zambia	42	14
Zimbabwe	155	57

ter of those reported from Ethiopia. Improving the yield, therefore, is still a major challenge that needs to be overcome if communities are to be able to carry out sustained and effective control of schistosome-carrying snails.

Experiments using snails reared in the laboratory were designed to test the best

methods for producing endod extracts and the optimum application rates. Results using extracts of freeze-dried whole berries (table 3) on *Biomphalaria pfeifferi* snails confirmed that the source of the endod had little effect on its molluscicidal properties and that a rate of 60 parts per million was enough to kill 100 per cent of the snails. By grinding the

berries to a powder, either mechanically or in a mortar and pestle, 10 parts per million were enough to kill all the snails, presumably because more of the component saponins were released into solution. Tests with two other snail species, *Biomphalaria glabrata* and *Bulinus truncates*, confirmed the broad molluscicidal activity of the endod extracts.

For effective control of bilharzia-carrying snails, therefore, the amount of endod powder applied to a particular pond must reach above 50 parts per million. The rate of application also depends on the flow-rate of water in the pond, which is determined prior to each treatment.

PARTNERSHIPS

In addition to staff from SIREMIFOP, project participants included the Bilharzia Unit of the Ministry of Health and Social Welfare and the communities of Ntfontjeni Inkhundla and Manzini North Inkhundla, areas where bilharzia is endemic. These partnerships were established through the SIREMIFOP outreach programme to create an interdisciplinary research team to address health issues at the grass-roots level. The Bilharzia Unit of the Ministry of Health and Social Welfare was responsible for screening and treating infected people, while the com-

Table 3 | Molluscicidal effect on *Biomphalaria pfeifferi* snails of freeze-dried endod berries from different locations applied at different rates.

Concentration of endod powder (parts per million)	SOURCE OF ENDOD					
	BIG BEND (LOWVELD)		LUYENGO (MIDDLEVELD)		MOTSHANE (HIGHVELD)	
	No. of snails killed*	Percentage of snails killed	No. of snails killed *	Percentage of snails killed	No. of snails killed*	Percentage of snails killed
0 (control)	0	0	0	0	0	0
10	0	0	0	0	0	0
20	0	0	0	0	0	0
30	0	0	0	0	0	0
40	4	13	3	10	3	10
50	26	86	27	90	27	90
60	30	100	30	100	30	100

* out of 30 per experiment

munities at Manzini and Ntfontjeni were responsible for the cultivation of endod.

Other regional and international collaborators included the University of Potchefstroom, the Royal Danish School of Pharmacy and Dr. Legesse Wolde-Yohannes, an endod specialist from Ethiopia.

REPLICABILITY

In 1983, the WHO Special Programme in Tropical Diseases (Schistosomiasis Scientific Working Group) identified endod as a botanical molluscicide. Since then, the plant has been used widely in many countries, particularly Ethiopia and Zimbabwe.

POLICY IMPLICATIONS

It was discovered recently that some schistosomiasis patients were not responding to the drugs normally used to treat the disease. The reason for the ineffectiveness of the drugs in these patients is unknown. It has been speculated, however, that the immune status of the patients may have been compromised owing to infection with HIV/AIDS. The Ministry of Health and Social Welfare intends to study the impact of the immune status of people on their response to drugs used for the treatment of schistosomiasis to establish whether or not HIV infection plays any role in this observation.

LESSONS LEARNED

There is an ongoing need for funding for the project. Approaches are being made to donor agencies to fund further research.

By involving the local communities at all stages of the project and by keeping them aware of the results of laboratory and field trials, the two Inkhundla communities were more willing to participate in the project, which has led to its success.

IMPACT

The willing participation of the two local communities should encourage other communities in areas where schistosomiasis is endemic to put the project's recommendations into practice.

The application of the project's findings should also be quite sustainable as endod can be cultivated in the communities where it is needed and its preparation and application to snail-infested ponds are simple procedures.

FUTURE PLANS

At the start of the project, baseline levels of schistosomiasis infection in the two communities involved were established. Follow-up studies need to be carried out to determine the effectiveness of the project with respect to public health.

There are also plans to involve other Inkhundla centres so that all parts of Swaziland where schistosomiasis is endemic will be covered and endod berries will be available on a large scale as an industrial product.

A proposal is being developed to enhance networking among countries where schistosomiasis is endemic. The proposal is being submitted to the United Nations University and the Third World Network of Scientific Organizations (TWNISO).

In addition, it has recently been observed that water bodies in the highveld, which was normally too cold to support snail survival, now harbour snails that can act as the intermediate hosts of schistosomes. This phenomenon has resulted in the spread of schistosomiasis to new areas, thus further spreading the disease throughout the country. This rise in water temperature in the highveld will be monitored.

PUBLICATIONS

Amusan, O.O.G., Msonthi, J.D. and Makhubu, L.P. (1995). Molluscicidal activity of *Spathodea campanulata*, *Andrachne ovalis*, *Phytolacca dodecandra* and *Hypoxis rooperi*. *Fitoterapia*, LXVII:113-116.

Lemma, A., Heyneman, D. and Silangwa, S.M. (1983). *Phytolacca dodecandra* (endod). Final Report of the International Scientific Workshop, Lusaka, Zambia, March 1983.

Makhubu, L.P. (1984). Testing the potential of the plant *Phytolacca dodecandra* as a plant molluscicide in the control of schistosomiasis in Swaziland. Final Report. United States Agency for International Development (USAID), Project No. 1936.

Makhubu, L.P., Lemma, L. and Heyneman, D. (1986). Endod II (*Phytolacca dodecandra*). Report of the Second International Workshop on Endod, *Phytolacca dodecandra*, Mbabane, Swaziland, April 1986.

Makhubu, L.P., Msonthi, J.D. and Amusan, O.O.G. (1993). *Phytolacca dodecandra* (endod). Report on field-testing of endod, Project RAF/87/T01, submitted to UNDP, Swaziland.

Case study prepared by:

Lydia Makhubu

Swaziland Institute for Research in Traditional Medicine, Medicinal and Indigenous Food Plants, University of Swaziland, Private Bag 4, Kwaluseni, Swaziland.

Tel.: (+268) 518 6816

Fax: (+268) 518 5605

E-mail: sharon@uniswacc.uniswa.sz

Project participants:

From the University of Swaziland:

L.P. Makhubu: Medicinal chemist, Chemistry Department.

O.T. Edje: Agronomist, Crop Production Department.

O.O.G. Amusan: Medicinal chemist,

Chemistry Department.

D.A. Otiemo: Natural products chemist,
Chemistry Department.

N.A. Sukati: Faculty of Health Sciences.

From other institutions:

M.S. Shongwe: Taxonomist in training,
University of Pretoria, South Africa.

P. Dlamini: Bilharzia Control Centre,
Ministry of Health and Social Welfare.

G. Dlamini: Curator, National Herbarium,
Ministry of Agriculture.

C.T. Wolmarans: Epidemiologist,
University of Potchefstroom, South
Africa.

Legesse Wolde-Yohannes: Endod consultant,
Ethiopia.
