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CONTROL OF *SCHISTOSOMA MANSONI* BY THE SOAPBERRY ENDOD (*PHYTOLACCA DODECANDRA*) IN WOLLO, NORTHEASTERN ETHIOPIA: POST-INTERVENTION PREVALENCE

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ABSTRACT

Objectives: To record the effect of Endod soap and spraying of soaked Endod suspension on the prevalence of human schistosomiasis.

Design: A cross-sectional epidemiological study in which pre- and post-intervention parasitological results were compared.

Setting: Kemise, Bati and Harbu towns in northeastern Ethiopia.

Subjects: The study subjects included all members of the five per cent households systematically selected from the three towns.

Results: In Kemise town, where suspension of ground Endod was sprayed on the stream containing infected snails, the prevalence of the disease was reduced from 59% to 53% and the mean intensity of infection was reduced from 239 eggs per gram (EPG) of faeces to 99 EPG ($p < 0.05$). In Bati town where Endod soap approach was used, the respective reduction in the prevalence and intensity of infection was from 51% to 43% and from 195 EPG to 162 EPG ($p < 0.05$). There was also a significant reduction of the disease in the control town probably due to the effects of praziquantel treatment and other factors.

Conclusion: The reduction achieved in the prevalence and intensity of schistosomiasis after an intervention period of four years was limited. This observation corroborates the fact that molluscicides must always be considered as supplementary to chemotherapy in the control of schistosomiasis. Although both approaches can be used, the spraying approach appears to be simpler and more feasible because two or three times yearly application of Endod suspension would suppress snail population and reduce transmission. Nevertheless, the choice as to what approach to use must be made on the basis of community preference, and for some soap-effect of Endod would be attractive

INTRODUCTION

Two forms of human schistosomiasis occur in Ethiopia: *Schistosoma mansoni* transmitted by *Biomphalaria pfeifferi* and *B. sudanica* and *Schistosoma haematobium* transmitted by *Bulinus abyssinicus* and *B. africanus*. *Schistosoma mansoni* is widely distributed and is more rapidly spreading in connection with water resources development and intensive population movements, while *Schistosoma haematobium* has so far been reported from three foci in western and eastern low lands of Ethiopia. The number of known endemic localities for *Schistosoma mansoni* has increased from less than ten between 1930s and 1970s to some 45 at present(1-3). Despite its significant public health and socio-economic impact, the control of the disease has not received due priority from health authorities. Control efforts made so far have been limited to few pilot trials towards the development of control strategies.

The discovery of molluscicidal properties of Endod (*Phytolacca dodecandra*) by Lemma(4) has been a major breakthrough in combating intermediate snail hosts in schistosomiasis control in Ethiopia. This plant is well known to the traditional Ethiopians because the berries were commonly used for different purposes such as washing clothes, treatment of certain ailments and as abortifacient. The fact that Endod grows locally and is biodegradable, makes it ecologically and economically more acceptable for use in schistosomiasis control compared to synthetic molluscicides.

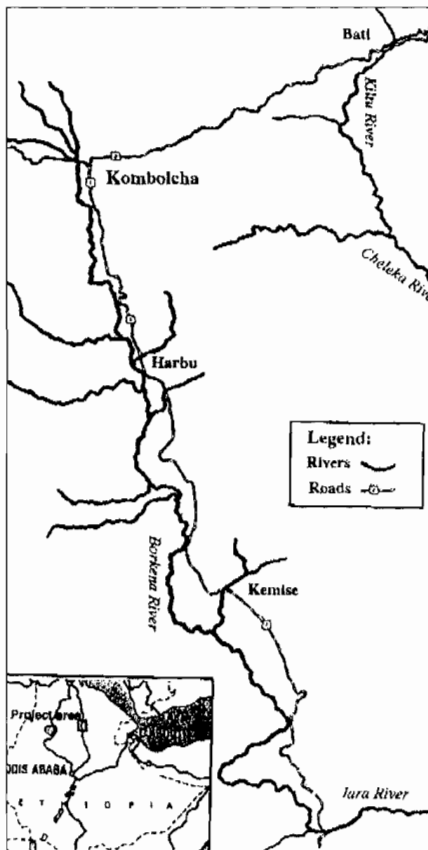
In 1994, an Endod-based pilot control trial of intestinal schistosomiasis was initiated in Kemise and Bati towns, northeastern Ethiopia, with the objective of developing a strategy for snail control by using Endod berries as a molluscicide and containment of the disease. The baseline epidemiological data to establish a basis of evaluation was collected prior to implementation of the programme and the results have been published(5). Kemise, ground

Endod berries soaked for 16 hours were applied as suspension by spraying for six hours, two or three times a year when snails were present while Endod soap was distributed every Saturday and Sunday to people washing clothes at the stream in Bati town. The amount of Endod applied was calculated based on water discharges. Harbu town which has a similar schistosomiasis transmission ecology but with considerably lower infection rates than Bati and Kemise towns, was used as a control town where no intervention was made. This study reports the effect of the two strategies on human schistosomiasis after a period of four years, whereas the molluscicidal effects and the results of the parallel re-infection studies on school children will be published elsewhere.

MATERIALS AND METHODS

Study area and population: The map (Figure 1) shows the study area which has been described in detail previously(5). Kemise, Harbu and Bati are small towns located 325 km, 355 km, and 415 km respectively, northeast of Addis Ababa. They are located at intermediate altitudes ranging from 1000 to 2000 metres above sea level. Kemise had 12,000 inhabitants, Bati 14,000 and Harbu 8000. The majority of the inhabitants of the three towns are Muslims, while the minority are Christians of different denominations. Each town is served by moderately staffed health centre.

Figure 1
Study area



All streams in the three towns harbour *Biomphalaria pfeifferi*, which transmits *Schistosoma mansoni*. Kemise town is flanked by two streams in the north and south both of which flow into the Borkena river. In Bati, Kiltu stream flows on the northern side of the present town from the east to the west. Harbu town is traversed by one stream which also flows into Borkena river.

There had been ongoing incidence studies on schistosomiasis in all the three towns parallel to Endod-based intervention. A cohort of infected school children were treated with praziquantel 40 mg/kg annually in each town, in order to study re-infection rates. The size of the cohorts treated were similar in all the three towns irrespective of the population size of the towns. At the end of the study, all infected participants were treated with praziquantel. The results of these studies will be published elsewhere.

Spraying method: In Kemise town, ground Endod berries were soaked for 16 hours and applied as a suspension to the water containing infected snails for six hours two or three times a year in the dry season. The amount of Endod required for six hours application was calculated using the formula (Q x concentration (ppm) x 6 hours x 60 minutes x 60 seconds), where Q is water discharge obtained by multiplying the width of the stream (in m) by velocity (in m/s) by water depth (in m), by the constant (0.8). Multiplication by a constant was done to make allowance for roughness of the stream-bed. The suspension was applied by continuous spraying using simple garden watering cans on both sides of the river simultaneously by two persons on each side covering 250 meters.

The concentration of Endod used was 25g/m³. Based on previous experiments, it was assumed that this concentration of Endod obtained and applied as above, would have molluscicidal effect along 250 meters downstream. Application was made in the major human water contact points. Initially the method of application used was drip-feeding, but this was changed to spray method in the course of intervention due to inefficiencies observed with the former. Firstly, it was observed that Endod solution was concentrating on the center of the stream when using the drip-feeding while most of the snails are found at the edges of the stream. Secondly, Endod residue clogs the siphoning tube and interrupts the flow of the solution.

Endod soap: In Bati town, Endod soap (250 or 500 grams of ground berry in polythene bags) was distributed to persons washing clothes at the streams on Saturdays and Sundays. These days of the week are preferred by most people of the area for washing. The compositions of the soap were ground Endod berry, kaolin and monstral blue in proportions of 1:1:1/100. Kaolin was used as a carrier or filler agent while monstral blue was used as a colouring agent. The amount of Endod soap distributed was calculated on the basis of the water discharge (Q) as in Kemise town, but only 1/12th of the amount was applied every week so that the annual supplementation would be about the same.

Control town: The town of Harbu was used as control where neither Endod soap nor spraying approach was used. The town has the lowest population and the prevalence of the disease was also low compared to Kemise and Bati towns. However, it had similar stream transmission ecology to the two intervention towns.

Selection of the study subjects and stool examination: A cross-sectional survey of intestinal schistosomiasis was carried out by systematic sampling of five per cent of households in Kemise, Bati and Harbu towns, northeastern Ethiopia, in October 1998. The sample size was determined on the basis of the previous prevalence report(5) and an assumption that 10% reduction would be achieved. To determine the number of households and of persons required, an average family size of five was assumed. To make allowance for non-respondents and to consider the effect of clustering, 10 extra households were

Table 1

Pre- and post-intervention prevalence and intensity of schistosomiasis mansoni in Kemise, Bati and Harbu towns, Wollo, northeast Ethiopia

	Town	Number infected/Number examined (%)			Intensity (EPG), Geom. mean		
		Male	Female	Total	Male	Female	Total
Pre-intervention (June 1994*)	Kemise	230/388 (59%)	212/363 (58%)	442/751 (59%)	236	241	239
	Bati	133/283 (47%)	183/333 (55%)	316/616 (51%)	165	220	195
	Harbu	68/222 (31%)	77/224 (34%)	145/446 (33%)	123	121	122
Post-intervention (October 1998)	Kemise	211/395 (53%)	223/420 (53%)	434/815 (53%)	102	96	99
	Bati	108/221 (49%)	65/182 (35%)	173/403 (43%)	205	112	162
	Harbu	18/151 (12%)	18/131 (13%)	36/282 (13%)	86	56	70

*Based on data from Birrie *et al*(5)

Table 2

Pre- and post-intervention age specific prevalence of schistosomiasis mansoni in Kemise, Bati and Harbu towns

Age group (years)	No. infected/number examined (%)					
	Kemise		Bati		Harbu	
	Pre-intervention	Post-intervention	Pre-intervention	Post-intervention	Pre-intervention	Post-intervention
<10	125/282 (44%)	73/193 (38%)	49/170 (29%)	16/83 (19%)	36/121 (30%)	4/60 (7%)
10-14	109/128 (85%)	91/139 (66%)	63/95 (66%)	48/76 (63%)	39/75 (52%)	8/51 (16%)
15-19	38/56 (68%)	72/114 (63%)	51/74 (69%)	38/61 (62%)	16/36 (44%)	4/30 (13%)
20-29	65/100 (65%)	79/141 (56%)	54/83 (65%)	28/72 (39%)	17/71 (24%)	5/41 (12%)
30-39	60/97 (62%)	54/106 (51%)	27/65 (42%)	14/30 (47%)	19/52 (37%)	9/35 (26%)
>40	45/88 (51%)	65/122 (53%)	72/129 (56%)	29/81 (36%)	18/91 (20%)	6/65 (9%)
Overall	442/751 (59%)	434/815 (53%)	316/616 (51%)	173/403 (43%)	145/446 (33%)	36/282 (13%)

included. A house-to-house visit was made to explain the objective of the study and at the same time small pieces of plastic sheets were distributed to all household members present at home to obtain stool specimens. The specimens were processed using modified Kato-Katz smear (one slide per stool specimen) employing a template delivering a plug of 41.7 mg of stool(6). Qualitative examination of the specimens was made within 24 hours and individuals who were found positive for *S. mansoni*, were treated with praziquantel in a single dose of 40 mg/kg body weights. Quantitative examination of the slides was made within one week of collection.

Data analysis: Egg count for *S. mansoni* was standardised by multiplying the number of eggs counted in 41.7 mg of stool by 24 to obtain eggs per gram (EPG) of stool. Intensity of infection was expressed as geometric mean. Relevant information was entered on a computer using Stata Version 5 software. Statistical significance of the results was assessed using the Student t-test and 95% confidence intervals.

RESULTS

Table 1 shows pre- and post-intervention prevalence and the intensity of infection in Kemise, Bati and Harbu towns. Comparison of the overall pre- and post-intervention results showed that there was significant reduction ($p < 0.05$) both in prevalence and intensity of *Schistosoma mansoni* infection in all the three towns.

In Kemise town, significant reduction was achieved both for prevalence and intensity of infection in both sexes

($p < 0.05$). In Bati town, there was a slight increase in prevalence of infection among males. However, this was not statistically significant ($p > 0.05$). In the females, the reduction in prevalence was from 55% to 36% and this reduction was significant ($p < 0.05$).

Pre- and post-intervention age specific prevalence of schistosomiasis in the three towns is shown in Table 2. The overall age specific prevalence of the disease appeared to be reduced both in the intervention and control towns. However, the most significant reduction was observed in Kemise ($p < 0.05$). In Harbu town, where no Endod-based intervention was made, reduction in prevalence and the intensity of infection also appeared to be pronounced.

DISCUSSION

Both the Endod-soap and spraying approaches had limited impact on the prevalence and intensity of schistosome infection after four years of intervention period. This is not unexpected. Mollusciciding only kills intermediate snail hosts and schistosome larvae present in water while the schistosome stage that already exists in human host is not affected. Therefore, in all control measures that do not involve chemotherapy, decline in prevalence is gradual even if the level of transmission falls, due to longer duration of infection. The mean life span of *S. mansoni* and *S. haematobium* worms on the basis of community studies has

been estimated to be three to ten years (7 - 10). If the life span of adult worms average six years according to this estimate, continuous application of Endod for over six years is required to achieve a significant reduction in prevalence of the disease. Furthermore, the likelihood of achieving a significant reduction in the magnitude of schistosomiasis in the community to a level at which it is no longer of public health importance by snail control alone, is counteracted by the hermaphroditic nature of the biomphalarid snail hosts. A single survivor biomphalarid snail can re-populate a habitat and become infected to maintain the level of infection in human population. In addition, in endemic foci where transmission takes place in flowing water bodies such as Kemise and Bati streams, snails transported from upstream may become infected in the control stream stretch as long as infection sources are present in human population.

Decline in prevalence of the disease in Harbu town without molluscicidal Endod intervention could possibly be explained by the effect of annual praziquantel treatment of a majority of the schoolchildren, who probably are the major agents for transmission of infection. Because of the relatively small population of the town and originally lower infection rates, the annual cohort treatment can be assumed to have more impact on transmission than in the larger Endod intervention towns. Furthermore, it was observed that the intensity of flood was often higher in Harbu stream and this might have flushed snail hosts out of their habitat, thereby reducing the risk of human re-infection as compared to streams in the other two intervention towns.

Although Endod soap and spraying approaches did not differ significantly in their impact on the magnitude of schistosomiasis, the Endod soap approach involving weekly distribution of the soap was found to be more labourious, time consuming and required more organisation of the community to prepare and deliver the soap powder. On the other hand, spraying approach involved only two or three times yearly application of Endod as suspension. This was found to be more simple and feasible than Endod soap approach and is recommended for use in conjunction with chemotherapy in schistosomiasis control programme. In addition, laboratory experiments conducted to compare the efficacy of the two approaches has shown that Endod soaked for 16 hours gave a snail mortality of 100% at a concentration of 25 ppm, while Endod soap soaked for 16 hours for 5 minutes (approximate time for rinsing clothes) only gave a mortality rate of 40% at the same concentration. This difference in efficacy between the two approaches might be attributable to fermentation process with soaked berries, the process which is important for the release of active materials (11). Although the time of washing clothes took more than 5 minutes, over night soaking of Endod before spraying seemed to release more of active ingredient of the Endod berries. Therefore, spraying method seems to be more economic to use as a supportive measure to chemotherapy in schistosomiasis control programme.

The present findings show that major reductions in human prevalence and intensities of infection cannot be expected in a few years with Endod-based snail control. However, one of the Endod-based molluscicide approaches can be used in conjunction with chemotherapy in schistosomiasis control programmes. Because of the dual advantage of Endod soap, that it can be used both for laundering and killing snails, the weekly Endod soap approaches can also be used as an alternative instead of traditional two to three times yearly application of Endod by spraying.

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