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Impact of Ecological Sanitation in Katiola, an Endemic Area of Schistosomiasis (Ivory Coast; West Africa)

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Abstract: *The use of urine as fertilizer in irrigated rice in Katiola an endemic area for schistosomiasis brings us to determine the impact of the approach of ecological sanitation in the development cycle of this parasitic disease. Investigations have revealed a low prevalence in our study area. The Environmental impacts of the Ecosan Project is improvement of health by minimizing the introduction of pathogens from human community. Indeed this practice increases the pH that will contribute to the destruction of germs and inhibit the cycle development and therefore the spread of germs including schistosomes after 45 days of storage. The urine* If *it is recycled can eliminated the pollution and health threats.*

Keywords: *Ecological sanitation, impact, schistosomiasis, Ivory Coast.*

1. INTRODUCTION

Many Artificial structures, such as dams were especially built in Center and North of Ivory Coast, where increased human demands on water resources because of hydrological deficit. These dams that are favorable habitats for the transmission of parasites [1] contribute to the survival of the population through the development of rice schemes. The need for flood control severely constrain the preservation of biodiversity [2]. These various agricultural activities leads to increase pressure on arable land, limiting crop yields. In a situation of food insecurity, decreasing soil fertility and escalating prices for fertilizers in world markets, there is a need to utilise the nutrients, especially in human urine, rich in nitrogen and phosphates, for agricultural purposes, thereby increasing productivity and reducing the needs for fertilisers. Also, in view of the problems with continuous use of drugs [3], there is an onus on applied freshwater ecologists to provide new approaches, techniques and methods that are safe and sustainable [4]. Previous works put forward an alternative to conventional sanitation called ecological sanitation. It is based on an ecosystem approach and treats human urine and faeces as a valuable resource to be recycled. Also, in order to diversify crops, fertilizing with urine in irrigated rice is tested in the Katiola department (central northern of Ivory Coast). Urine is a natural fertilizer, rich in nutrients, cheaper and environmentally friendly unlike chemical fertilizers that are out of the reach of small farmers and likely to degrade aquatic ecosystems. This new approach which consiste on sanitized the urine before its recovery and reuse, presents a potential public health risk because the area is endemic to schistosomiasis. However, it reduced input costs and would also have important implications in the epidemiology and control of the disease. Our study aimed to provide informations about prevalence of human urinary schistosomiasis and the possible impact of ecological sanitation on this endemic parasitic disease of this tropical areas.

2. MATERIALS AND METHODS

2.1. Study Area Description

The study was carried out at Katiola located in north-central Ivory Coast (Fig. 1), approximatively 430 km from Abidjan the economical capital between 8°00' and 9°20' N, and 4°43' and 5°78' N and an altitude of about 320 meters. The town covers 9420 km² and has three dams with irrigated perimeter Nianra and Lopé covering respectively 37, 76 and 29 hectares.

Figure 1. *Map showing the three sampling sites in the study area.*

2.2. Collecting Methods

2.1.1. Human schistosomiasis survey

Urine were collected according to [5] from three different sites (Nianra and Lopé). All the samples of urine were provided by volunteers up to five years old (those that have been treated by Praziquantel during the last 12 months were excluded). The urine samples were recovered in two plastic bottles of 150 mL. The samples were considered positive or negative by using the method of egg concentration. Egg concentration was made as follows. Each urine sample was centrifuged and filtered through the 45 µm pore size sieve using a pump with pressure containing physiological saline. Whatever the sample, the eggs trapped in the residues retained by the last sieve (45 µm) were recovered in a glass beaker (3.5 cm high and 6 cm in diameter) in physiological saline (50 mL). The presence of eggs and their morphology were assessed under a binocular microscope by screening up to five aliquots (maximum 1 mL) for each urine sample, recovered from the bottom of the glass beakers. This assessment stopped as soon as eggs were seen in an aliquot.

2.1.2. Miracidial hatching

150 urine samples of 50 mL each containing eggs where tested for the impact of ecological sanitation on parasitic cycle. 30 of them constituted the reference were not sanitized and the other 90 were subjected to sanitation procedure. The miracidial hatching was assessed by screening 30 samples respectively at the beginin (J_0; reference), 10 (J_{10}), 20 (J_{20}), 30 (J_{30}) and 45 days (J_{45}) after the start of the sanitation, pH and temperature of each urine sample were also mesured during

storage. The samples were individually filtered through the 45µm pore size sieve. The residues were placed in a glass beaker containing well water and under light for egg hatching. All the samples containing viable eggs produced living miracidia. The samples were considered positive or negative by using the method of egg concentration and miracidial hatching. Detection of at least one living miracidium signed for the positiveness of the sample. This qualitative method is more reliable than others because it is made on the whole urine and because the positiveness depends exclusively on the presence of living miracidia, i.e. on possible parasite transmission, and not on the only presence of eggs. However, it takes longer time.

3. RESULTS

3.1. Prevalences of Schistosomiasis in Humans

A total of 158 volunteers were screened during this study, four of them were excreting Schistosoma eggs corresponding to a prevalence of 2.53% (Table 1). In Nianra, the prevalence of schistosomiasis was 2.42% (3 volunteers were positive out of 124 screened). In Lopé 2.94% of the screened volunteers were positive (1 out of 34 screened).

Table 1. *Natural prevalence (expressed in percentage) of Schistosoma eggs in humans urine*

Sites	Volunteers screened	infected	Prevalence (%)
Nianra	124	3	2.42
Lopé	34	1	2.94

Investigations in order to determine the prevalence, generally concerne pupils of 5 to 15 years, who are a relevant indicator of prevalence at the community level [6]. Urine analysis show a very low prevalence of schistosomiasis (2.53%) across the two schemes compared to previous studies. Indeed, higher prevalence rates were recorded in Mali, 27.8% in rural areas [7], 60.8% in urban areas [8] and 72% rate in irrigated rice schemes [9]. It is the same in Burkina Faso where [10] obtained rates ranging from 10.5 to 75.5%. in three villages In Cote d'Ivoire, [11] obtained a rate of 28.91%, [12] obtained an average rate of 32% in four localities in the north (Sambakaha, Katiali, Gboyo and Nambengué). All these results, whatever the source, show that the prevalence of urinary schistosomiasis obtained in the rice growing areas of Nianra and Lope is low.

The weakness of the prevalence of schistosomiasis on the perimeters would be due to the different activities of rice culture that cause changes in the environment, creating a demographic and genetic imbalance in snail hosts of schistosomiasis [13].This kind of environment is unfavorable to the proliferation of vectors and therefore infective parasites. We may also believe that urine used as fertilizer with a high pH is a limiting factor in the spread of these germs.

However, this weakness does not exclude a potential health risk in the study area, the extent of the snail intermediate hosts of this disease have been harvested and tested successfully with the issue of cercariae [14]. The results of this study provide information on the presence of urinary schistosomiasis in irrigated areas of Lope and Nianra. These schemes are in endemic area for this disease and therefore we must ensure that the urine used as fertilizer in irrigated rice in these areas is free from *Schistosoma haematobium* eggs.

3.2. Miracidial Hatching

Temporal variations in pH, temperature and Miracidial hatching are shown in table 2. pH shows low variations (8.48 - 8.74) and urine temperature measured varies from 27.1 to 28.2 °C.

Table 2. *pH, Temperature and number of living miracidia in urine samples during the sanitation.*

Samples	pH	Temperature (°C)	Number of samples with living miracidia / 30
J_0	8.48	28.1	24
J_{10}	8.70	28,2	1
J_{20}	8.71	27.1	0
J_{30}	8.72	27.1	0
J_{45}	8.74	27.4	0

The analysis shows that 80% of the reference samples (J_0) containing viable eggs produced living miracidia, however no parasite is produced after 10 days of sanitation. The important thing here is the status of eggs (Fig. 2). In the case of this study, only the date of incorporation of the primary sample (J_0) that eggs are alive. They are moving at J_0 with very mall movements and will remain inert until 45 days (J_{45}) and more or less degraded.

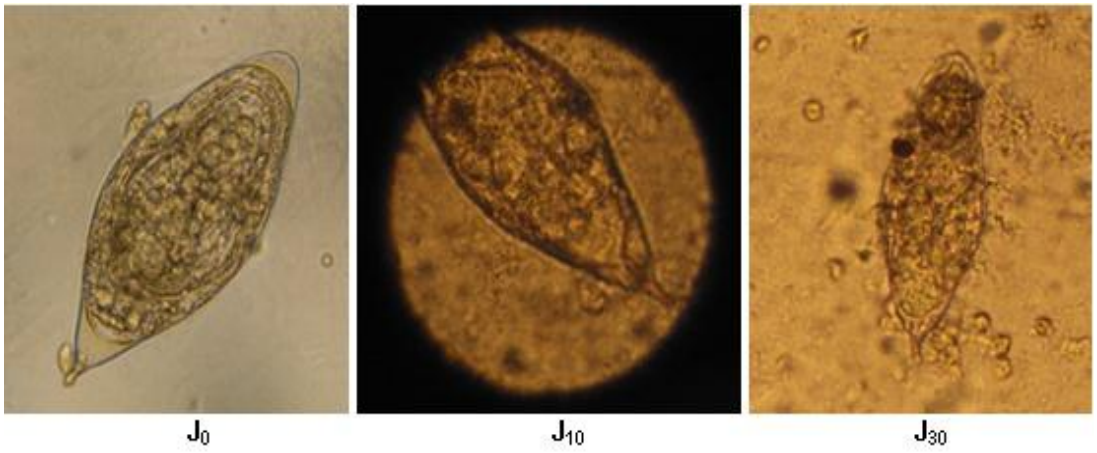

Figure 2. *Schistosoma haematobium eggs view under the microscope during sanitation.*

The aim of this study focuses on the ability of the sanitation system of the EcoSan approach to eliminate parasites, including *Schistosoma* eggs in the urine collected for fertilization. The results of the physical parameters show that the pH of the urine is stored unbearable germs and especially parasites. These results are confirmed by [15] which show that the basic pH leads to the elimination of fecal bacteria (including fecal coliform and Anaerobic sulphite-reducing), which are bacteria. Therefore parasites, fragile microorganisms (because not live at the expense of their hosts) are quickly eliminated in the early hours of cleaning [16; 17]. Previous studies have shown inactivation of *Schistosoma haematobium* in urine [18; 17]. [19] showed that if the urine is stored for several days at a temperature of 20 °C and / or used on arable land, its use decreases the risk of transmission of schistosomiasis. Katiola temperatures are around 30 °C and therefore more effective in killing bacteria. Only use fresh urine should be avoided in or near surface water in endemic areas.

The eggs are very persistent and can live in very hostile environments through their thick, hard and smooth shells that protect them [5]. Schistosome eggs can be found in the urine after 45 days of storage. However, these eggs are more or less altered after a significant period of conservation. They are used just to indicate the presence of bilharzia and are unable to infective larval hatching even if they are released into the natural environment favorable to their development. Indeed, according to [20], the schistosome egg can not withstand the outside environment than 7 to 10 days and in optimal conditions of temperature (25 - 30 °C), illumination and pH neutral. These conditions are hardly provided the parasite eggs when cleaning. This makes it easy to understand the inactivation of eggs obtained during storage of urine. Therefore, it is right to say that the sanitation system in place is effective in eliminating the parasite eggs in collected urine. The sanitized urine has a basic pH and is unbearable by microbial pathogens. It inactivates more persistent, especially *schistosoma* eggs. Therefore the contribution of this urine increases the pH that will contribute to the destruction of germs and inhibit the cycle development and therefore the spread of germs including schistosomes.

4. CONCLUSION

The study showed that the sanitation system of the EcoSan approach effectively eliminates the parasites. In addition to eliminating germs in urine, it increases the pH that will contribute to the destruction of germs and inhibits the growth of microbial organisms, including schistosomes on rice growing areas fertilized with urine. However, the use of fresh urine should be avoided in endemic areas of schistosomiasis.

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