The acceptability and effectiveness of a polyester drinking-water filter in a dracunculiasis-endemic village in Northern Region, Ghana*

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In the global effort to eradicate dracunculiasis (guinea-worm disease) one of the main tools is the use of filters for filtering unsafe drinking-water. The expensive and high-quality monofilament nylon filters, which for many years were donated to all dracunculiasis-endemic countries, are now mainly reserved for highly endemic countries. Polyester cloth is less expensive, and we investigated the user acceptability and effectiveness of this material as a drinking-water filter in a dracunculiasis-endemic village in Northern Region, Ghana, over a 3-month period.

The polyester cloth completely retained the stages of copepods that are responsible for transmitting dracunculiasis. Over the 3-month study period a majority of respondents found that the new cloth was superior to the nylon filter with regard to strength (83%), filtering time (80%), and the ease with which the filter could be cleaned (87%). Inspection revealed that the filters were used intensively and that the new cloth was damaged after 2–3 months of use, which is also the case for the monofilament nylon filters.

Introduction

Dracunculiasis (guinea-worm disease) is a parasitic infection contracted by human ingestion of a larval nematode contained within the body of a copepod intermediate host. These copepods are typically found in the shallow stagnant pools and ponds used for drinking-water in rural areas.

The National Programme for Eradication of Guinea-worm in Ghana (GGWEP) is primarily based on surveillance and health education activities carried out through a hierarchical system of co-ordinators and volunteers from village to national level. The main health education message given by the village volunteers is to filter all drinking-water obtained from unsafe water sources.

For several years expensive and high-quality monofilament nylon filters have been donated to all countries where guinea-worm disease is endemic to assist in the efforts towards its eradication. Now, this donation is mainly reserved for highly endemic countries and the donors supporting the eradication programmes are searching for alternatives that have the same qualities as the nylon filters but which are affordable. Use of a polyester cloth filter, which costs approximately half

* *Editorial note*: WHO sent a sample of polyester fabric identical to the one used in this study and a sample of nylon fabric manufactured in the USA to Dr J-P. Chippaux, Director, Centre de Recherche sur les Méningites et les Schistosomoses, Niamey, Niger, to compare their effectiveness as filters against the intermediate hosts of guinea-worm disease. The nylon fabric has been widely and successfully used in national guinea-worm eradication programmes.

Dr Chippaux's conclusions were as follows:

The properties of the polyester fabric appear to be identical to those of the monofilament nylon fabric. There is a sealing delay with the polyester fabric, probably because of its looser mesh size. The mesh size does not, however, appear to heighten the risk of cyclops passing through. Cleaning is simpler and the filter regains all of its original properties. Under the particular conditions of the test, the polyester fabric exhibits qualities that are at least equal, if not superior to those of the monofilament nylon fabric. Its resistance to wear was not tested.

Dr Chippaux's findings are in accord with those of Dr Olsen et al. in this article, and since the polyester fabric is cheaper than nylon, it is an alternative worth considering in the campaign to eradicate guinea-worm disease.

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the price of the nylon filter, could be such an alternative.

The objectives of the present study were to test the ability of filters made from the polyester cloth to retain the stages of copepods that transmit guinea-worm disease and to investigate the filter's user acceptability with regard to strength, filtering time of silt-laden water, and the ease of cleaning.

Materials and methods

Study area. Northern Region is the largest region in Ghana, occupying approximately one-third of the total land mass, but having only 8% of the total population. There are over 1000 settlements with 200 or more inhabitants, but less than 2% of these have populations greater than 5000; thus, the settlements are many and widely scattered (*1*). Northern Region has always been the worst affected by dracunculiasis, and in 1995 accounted for 82% of all such cases in Ghana (*2*).

Samples of water from two copepod-infested reservoirs near the villages of Ghanasco and Lamashegu in Tamale District, Northern Region, were used for the laboratory tests of the ability of the filter cloth to retain copepods.

Zanteli, a highly endemic community (approximately 32 households) about 5 km away from Gushegu in Gushegu/Karaga District, Northern Region, was selected for the field testing of the filters.

Cloth material. In contrast to woven nylon monofilament filters, which have a regular mesh size of 0.100 mm (*3*), the filter material that we tested in this study is a knitted polyester cloth with an irregular mesh, whose size is not specified.

Intermediate hosts. The intermediate hosts of dracunculiasis are small cylindrical water-fleas belonging to the group cyclopoid copepods. The developmental stages of the copepods include the mature copepod, five immature copepodid stages, and six immature naupliar stages. Only the adult stage and the larger development stages are able to survive ingestion by guinea-worm larvae and thus act as intermediate hosts. The stages that transmit the infection are >0.350 mm in length and >0.135 mm in diameter (*4*). Therefore, any filter with a mesh size ≤0.135 mm is sufficient to retain all infected intermediate hosts.

Laboratory tests. Five water samples (10 litres each) were collected from different sites in each of the two copepod-infested reservoirs. Each sample was filtered through the polyester filter cloth. The filtered water as well as the residue left on the filters were examined for the presence of all stages of copepods. The number of copepods retained was obtained by backwashing the filter into a clean container. To count the copepods that passed through the cloth, the filtrate was passed through a 0.05-mm filter, which retained all stages of copepods. Subsequently, this filter was backwashed as described above. The material obtained from the backwashing was transferred to Petri dishes and counted under a dissection microscope after adding a few drops of 1 mol/l hydrochloric acid to kill the copepods. For comparison, five samples of water (50 ml each) were filtered through the monofilament nylon filter and the number of copepods retained and passed through the filter were treated as described above.

Household survey. The female heads of 31 of the households in Zanteli agreed to test the polyester filter cloth. All old monofilament nylon filters already in use were withdrawn from the participants and replaced with the new filters. Filters of the new material were cut to the same size as the monofilament filters and the women were told to use the new filters just as they had used the old ones. A village volunteer and the women leader in the village visited the households every day to ensure that all filters were used regularly and correctly. The district coordinator in charge of Gushegu/Karaga District visited the village twice a week to ensure further that the filters were being used correctly. Every household was visited once a month for three consecutive months to observe the physical condition of the filters and to administer a questionnaire to the female heads of the households. The respondents were asked their opinion about the qualities of the polyester filter compared with the nylon filter in terms of its strength, filtering time, and the ease with which it could be cleaned.

Results

In the present study the polyester filter was able to retain all stages of copepods from the smallest nauplius stage to the largest adult stage (Table 1). The larger stages (C4 and above) were completely retained by the new filter. Water passed through the monofilament nylon filter also did not contain the largest stages of copepods, with the exception of one C4 stage in one sample (Table 1).

The results of the household survey are shown in Table 2. During the period June to August, the

Table 1: **Number of copepods (by stage), in samples of water retained by and passed through the polyester cloth filter and number of copepods (by stage) passed through the monofilament nylon filter**

	Polyester cloth filter (10 l, n = 10)		Monofilament nylon filter (50 ml, n = 5)
Copepod stage[a]	Median number retained by filter	Median number in filtered water	Median number in filtered water
N1–N6	2 420 (1 235–3 180)[b]	1 802 (1 220–2 100)	67 (28–74)
C1	1 043 (190–1 960)	999 (220–1 200)	28 (5–43)
C2	990 (100–1 960)	480 (114–980)	11 (5–27)
C3	850 (120–1 450)	535 (134–1 160)	13 (3–21)
C4	850 (0–1 380)	0	0 (0–1)
C5	665 (0–2 000)	0	0
Adult female	575 (0–1 411)	0	0
Adult male	530 (0–1 601)	0	0

[a] N1–N6: nauplius stage 1 to 6; C1–C5: copepodid stage 1 to 5.
[b] Figures in parentheses are the range.

majority of respondents found the polyester cloth superior to the nylon filter with regard to strength (83%), filtering time (80%), and cleaning (87%). Satisfaction with the polyester cloth was slightly less at the beginning of the 3-month study period than at the end.

At the household visits in June, July, and August, respectively, 100%, 97%, and 92% of the filters, were inspected. All the filters were used intensively and at these visits 42%, 77%, and 81%, respectively, of the inspected filters had developed perforations because of friction along the edge of the water pots during the filtering process. Such damage is normally seen also with the nylon filters.

Table 2: **Respondents' opinions about the polyester cloth filter compared with the monofilament nylon filter with regard to strength, filtering time of silt-laden water, and the ease of cleaning**

	June	July	August	Mean
Total number of households visited	31	31	26	29
Strength of filter				
Stronger	74%	87%	88%	83%
Less strong	13%	6%	4%	8%
Same	3%	0	0	1%
Don't know	10%	7%	8%	8%
Filtering time				
Faster	68%	84%	88%	80%
Slower	26%	3%	0	10%
Same time	6%	10%	4%	7%
Don't know	0	3%	8%	3%
Cleaning of filter				
Easier	77%	91%	92%	87%
More difficult	7%	3%	0	3%
Same	16%	3%	0	6%
Don't know	0	3%	8%	4%

Discussion

In the present study, the polyester cloth was able to retain copepod stages from C4 and above, as did also the monofilament nylon filter of mesh size 0.100 mm. Filters with this particular mesh size were first recommended in 1984 (*5*) and since then only a few studies have examined the effectiveness of alternative filters. Sullivan & Long compared monofilament filters with mesh sizes of 0.100 mm and 0.200 mm in retaining *Mesocyclops aspericornis* and *Thermocyclops emini* and found that the 0.200-mm filter allowed the bigger immature stages (C3–C4) to pass through (*6*). A similar result was obtained in Pakistan with a *Mesocyclops* sp. (*7*). The epidemiological significance of this difference in the ability to retain these immature but potentially infective stages is unclear and no study has compared the two filter types with regard to strength, filtering time, and ease of cleaning. Filters with larger mesh openings could have better characteristics, and the study in Pakistan also showed that even after 12–15 months of regular use the 0.200-mm filters remained effective in removing copepods (*7*). Unfortunately, the durability of the 0.100-mm filters was not investigated. In Ghana, it is our experience that the 0.100-mm monofilament nylon filters should be replaced every 2–3 months, probably due to the often rough treatment they receive during cleaning. Although the majority of respondents found the new polyester filter stronger than the nylon filters, we expect that the polyester filters will have to be replaced as often as the nylon filters.

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Résumé

Acceptabilité et efficacité d'un tissu de polyester comme filtre pour l'eau de boisson, dans un village d'endémie dracunculienne de la Région Nord du Ghana

La dracunculose (ou maladie due au ver de guinée) est une parasitose que l'homme contracte en ingérant la larve d'un nématode présente dans un copépode, lequel est l'hôte intermédiaire dans le cycle évolutif de la maladie. Il est classique de rencontrer ces copépodes dans les eaux stagnantes et peu profondes des mares et des marigots utilisées comme eaux de boisson en zone rurale.

Le programme national d'éradication du ver de guinée (PNEVG) du Ghana repose essentiellement sur la surveillance et l'éducation sanitaire. Le message principal de cette dernière activité est la filtration de toute eau de boisson non salubre.

Les filtres en fibres monofilament de nylon, de bonne qualité mais coûteux, sont maintenant surtout réservés aux pays de forte endémicité. Les tissus en polyester sont moins chers et l'étude que nous avons réalisée au laboratoire montre qu'ils permettent de retenir tous les stades des copépodes qui transmettent l'infection. Nous avons aussi étudié, pendant une durée de trois mois, l'acceptabilité par l'utilisateur de ce tissu quant à la solidité, au temps de filtration et à la facilité de nettoyage, dans un village d'endémie dracunculienne situé dans la Région Nord du Ghana.

Les essais en laboratoire ont été effectués avec des échantillons d'eau contenant des copépodes et 31 villageoises ont accepté de tester ces filtres en polyester. Contrairement à la toile monofilament de nylon, qui est tissée et a un vide de maille régulier, en général de 0,100 mm, le tissu polyester étudié est tricoté, et les vides de maille sont difficiles à mesurer.

Les filtres en polyester ont retenu tous les stades évolutifs de copépode capables de transmettre la maladie. De juin à août, la plupart des personnes ayant répondu à l'enquête ont trouvé le filtre en polyester supérieur au filtre en nylon, quant à sa solidité (83%), au temps de filtration (80%), et à la facilité de nettoyage (87%). Lors des visites domiciliaires en juin, juillet et août, 100%, 97% et 92% respectivement des filtres ont été inspectés. On a observé à cette occasion des perforations circulaires occasionnées par le frottement du filtre sur le bord du récipient contenant l'eau sur respectivement 42%, 77% et 81% des filtres inspectés. Ce type de dégradation se produit également avec les filtres en nylon. Si les répondants à l'enquête estiment les nouveaux filtres en polyester plus solides que les filtres en nylon, il est toutefois probable que les filtres en polyester devront être remplacés aussi souvent que les filtres en nylon.

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