J. Hyg., Camb. (1982), **88**, 57
Printed in Great Britain

The sanitary condition of rural drinking water in a Nile Delta village

I. Parasitological assessment of 'zir' stored and direct tap water

BY AMAL E. M. KHAIRY, OLFAT EL SEBAIE, ALEYA ABDEL GAWAD AND LAILA EL ATTAR

Departments of Rural Health, Sanitary Chemistry and Microbiology, High Institute of Public Health, University of Alexandria

(*Received* 19 *March* 1981)

INTRODUCTION

Drinking water is a recognized mode of transmission of various parasitic and bacterial infections and high prevalence rates of water-borne infection have been found during past studies in rural areas of the Nile Delta (Farag *et al.* 1979; Khairy, Barakat & Omar, 1978).

The introduction of plant-treated water in rural areas of Egypt has only become general within the past century (Mohsen, 1978). Meanwhile, peasants have for years had their own means of collecting and storing water for domestic use. The 'zir', an earthenware, conical-bottomed pot, has been a commonly used storage utensil, particularly for cooling drinking water. The traditional use of these pots in many villages has continued in spite of the introduction of treated water not only via public taps, but also private taps within the houses.

The aim of this investigation was to assess the sanitary condition of 'zir' stored drinking water, compared with that of direct tap water, by studying its parasitological, bacteriological and chemical nature. This paper describes the parasitology.

METHODS

A systematic random sample of 107 of the 578 houses in Abbis II village in the Nile Delta was visited and samples of water were taken from zirs whenever found. Records were made for each zir consisting of data on the frequency and method of filling and cleaning, number of users, presence and type of cover, standard of cleanliness and also the proximity of the zir to animals. Water samples were analysed for chemical content and for intestinal parasites and bacteria. Samples were also taken from public and private taps for comparison.

Water sampling for parasitological assessment. The water in each zir was stirred well with the same utensil as used by the household for taking water; then a 2 l sample was taken in a clean plastic or glass container. Samples were transported to the High Institute of Public Health for preparation and microscopical examination.

Preparation and parasitological examination. The Chang & Kabler (1956) technique was used for preparation of water samples. Each sample was filtered through a 1·2 μm pore size membrane filter, 47 mm in diameter, with the aid of a suction pump. Towards the end of filtration the inside of the filter holder was washed with a jet of distilled water. Suction was stopped before the membrane was quite dry and the membrane removed to a beaker where it was thoroughly washed in 5 ml distilled water. The wash fluid was centrifuged at 1000 r.p.m. for 10 min. After aspiration of the supernatant the whole sediment was examined microscopically applying a drop of Lugol's iodine. Protozoan cysts and helminthic ova were sought in all the specimens and were counted in a subsample of them.

RESULTS

A total of 107 zir water samples was examined, counts were made on 25 samples. Eleven tap water samples were also examined of which eight were counted.

Table 1 shows the parasitic contamination rates of zir stored water in comparison with direct tap water. There were no significant differences in the presence of protozoan cysts between zir and tap water samples, but the prevalence differences of helminthic ova are clear; ova were absent from direct tap water, but found repeatedly in zir water samples, particularly prevalent were *Ascaris* (15 %) and *Strongyloides* (10·3 %).

Table 1. *Parasitic infection rates of zir stored versus direct tap water*

Parasite ...		*Ent. histolytica*	*Ent. coli*	*Giardia*	*Ascaris*	*Oxyuris*	*Trichuris*	*Ancylostoma*	*Strongyloides*	*Taenia*
Zir water	No.	59	87	38	16	1	2	4	11	1
107 samples	%	55·1	81·3	35·5	15	0·9	1·9	3·7	10·3	0·9
Tap water	No.	7	9	4	0	0	0	0	0	0
11 samples	%	63·6	81·8	36·4	0	0	0	0	0	0

Counts of protozoa in zir water and tap water were high, but did not differ greatly (*Entamoeba histolytica* zir water 14·5 ± 5·8/l, tap water 13·8 ± 5·7/l; *Ent. coli* 16·5 ± 8·1/l and 13 ± 5·9/l; *Giardia* 9·3 ± 8/l and 5·4 ± 8/l respectively).

There was no significant change of contamination rates with any of the parasites at varying time periods since the zir was last filled (Table 2). However, Fig. 1 shows that mean counts of protozoan cysts tended to be highest 12 h since last filling.

Table 2. *Some parasitic infection rates of zir water by period since last fill*

Parasite ...		*Ent. histolytica*	*Ent. coli*	*Giardia*	*Ascaris*
Period since last fill					
6 h	No.	15	25	8	6
27 samples	%	55·6	92·6	29·6	22·2
12 h	No.	31	42	25	7
56 samples	%	55·4	75·0	44·6	12·5
24 h	No.	13	20	5	3
24 samples	%	54·2	83·3	20·8	12·5

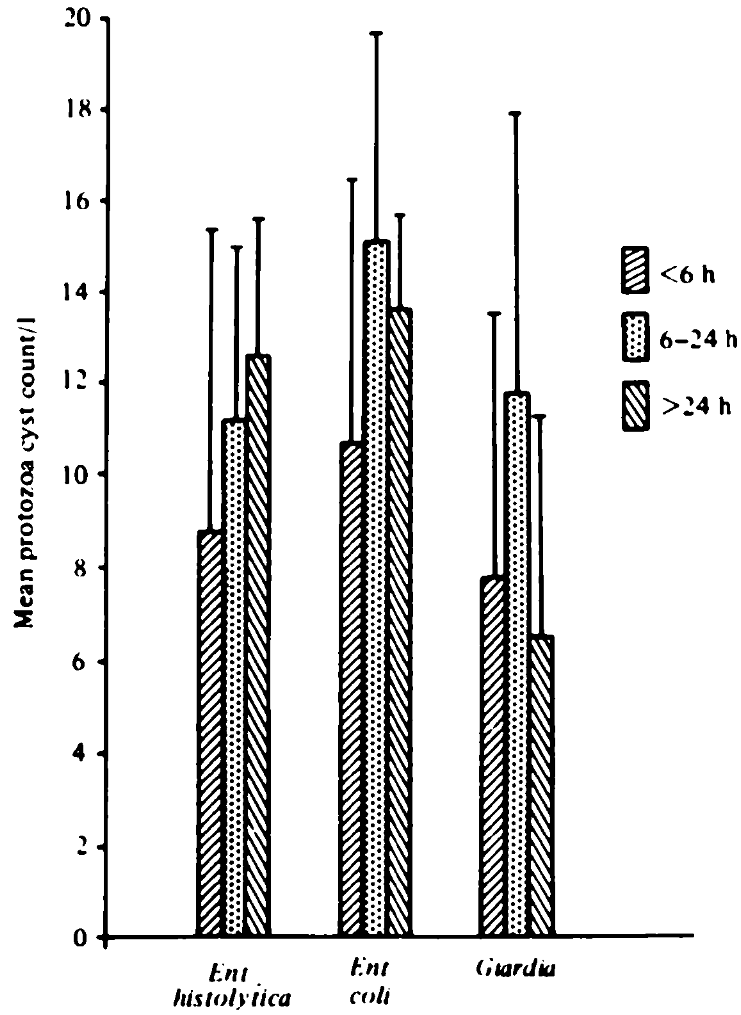

Fig. 1. Mean protozoa cyst count per litre at three intervals after last filling. Mean count and standard deviations are shown.

In Table 3 parasitic contamination rates of zir water are expressed by season. It is clear that while contamination rates for protozoa tend to be higher in winter, rates for helminthes are mostly higher in summer.

Table 3. *Some parasitic infection rates of zir water by season*

Parasite... Season		*Ent. histolytica*	*Ent. coli*	*Giardia*	*Ascaris*	*Oxyuris*	*Trichuris*	*Ancylostoma*	*Taenia*
Summer	No.	25*	43**	11***	11	1	4	1	1
59 samples	%	42·4	72·9	18·6	18·6	1·7	1·7	6·8	1·7
Winter	No.	34	44	27	5	0	1	0	0
48 samples	%	70·8	91·7	56·2	10·4	0	2·1	0	0

* χ^2 6·667, $P < 0·01$; ** χ^2 6·146, $P < 0·01$; *** χ^2 16·344, $P < 0·01$.

There was no significant difference in contamination rate of the zir water whether or not the family utensil had a handle. All zirs were covered with wooden, tin or other kinds of lids, but no significant difference in contamination rate or the zir water existed relative to the type of lid.

Table 4 shows that although zirs in proximity to birds had a higher contamination rate than those in proximity to mammals or where both were absent, this is statistically significant only in the case of proximity to both birds and mammals versus neither animal ($P < 0·05$).

https://doi.org/10.1017/S0022172400069898 Published online by Cambridge University Press

Table 4. *Some parasitic infection rates of zir water by vicinity of mammals and birds*

Parasite...		*Ent. histolytica*	*Ent. coli*	*Giardia*	*Ascaris*
Birds in vicinity	No.	8	11	6	3
14 samples	%	57·1	78·6	42·9	21·4
Mammals in vicinity	No.	3	5	2	0
7 samples	%	42·9	71·4	28·6	0
Both in vicinity	No.	4	5	0	3*
6 samples	%	66·7	83·3	0	50
No animals in vicinity	No.	37	59	23	10
73 samples	%	50·7	80·8	31·5	13·7

* χ^2 5·31, $P < 0·05$.

Chi square is performed for relationships between each of birds mammals or both with 'No. vicinity' group.

DISCUSSION

Supplying safe water differs greatly from simply supplying water. An unsafe water supply will not only fail to protect consumers against waterborne diseases, but will serve to disseminate these diseases more widely than would have been the case had consumers depended on their own private sources. It is obvious from the results of this study that the supply of safe rural drinking water still presents a problem. The high prevalence rate of protozoan cysts in direct tap water is alarming. Intestinal infections will not be controlled by sophisticated health care services or technology, if a safe adequate water supply is not provided.

Table 1 shows that the role of the zir in transmission of parasitic infections cannot be ignored. Helminthic ova are probably introduced into the water during its storage, being totally absent from direct tap water samples. The highest helminthic contamination rate of zir water is that of *Ascaris*, the eggs of which can remain alive in cold water for months (Faust & Russel, 1958). On the other hand, protozoan cysts seem to exist in the water leaving the taps and are added to during the storage period. Birmingham *et al.* (1979) stated that cysts of *Giardia* can remain viable in cold water for up to 2 months; *Ent. histolytica* cysts can survive for several weeks.

Fig. 1 demonstrates that the intensity of water pollution rises in relation to the storage period, for up to 12 h; though the prevalence rate does not change (Table 2). This means that a zir is probably exposed to contamination as soon as it is filled, becoming a more potent means of transmission the longer the storage time.

The seasonal distribution of parasitic contamination of zir water, illustrated in Table 3, shows that while protozoan contamination is more prevalent in winter, helminthic contamination is more common during summer coinciding with the peak of human parasitic infections in summer. High winter prevalence rates of protozoa could be explained by the high tap water rates, which apparently do not drop in winter. At the same time, zir water use probably diminishes in winter, giving less need for refills and so prolonging periods of water storage.

Water taking is performed by dipping utensils, usually aluminium or tin cups and casseroles, with or without handles into the zir, but the presence or absence of a handle does not affect prevalence rates of the most common parasites. It is most likely, that the filling process involves dipping the fingers inside the zir, allowing transmission of infection. The utensil used could itself be a convenient vector.

According to Davies & Hibler (1979), domestic animals such as cattle, cats and dogs are the only possible animal carriers of *Giardia*. This was not confirmed in this study, but the role of birds is clear (Table 4) though the relationship is not statistically significant. Mechanical transmission is a possible explanation for the observation.

It can be concluded that more than taps and standpipes are needed to supply safe water to rural areas. Pollution through casing cracks, sewage leakage into the soil, or fouling of the source, could expose the entire community using it to infection. Thus waste water and sewage disposal also become necessities. Furthermore, attempts at modification of rural water storage methods are essential and should be included in health education programmes for safer water use.

REFERENCES

Birmingham, A. K., Jarrol, E. L., Meyer, E. A. & Rodulescu, S. (1979). *Giardia* sp. Physical factors of excystation in vitro and excystation versus eosin-exclusion as determinants of viability. *Experimental Parasitology* **47**, 284–291.

Chang, S. L. & Kabler, P. W. (1956). Detection of cysts of *Endamoeba histolytica* in tap water by the use of membrane filters. *American Journal of Hygiene* **64**, 170–180.

Davies, R. B. & Hibler, C. P. (1979). Animal reservoirs and cross-species transmission of Giardia. In *Waterborne Transmission of Giardiasis*. Proceedings of a symposium, September 1978, EPA-600/9-79-001, p. 104.

Farag, H. F., Barakat, R. M. R., Ragab, M. & Omar, E. (1979). A focus of human fascioliasis in the Nile Delta, Egypt. *The Journal of Tropical Medicine and Hygiene*, **82**, 188–190.

Faust, E. S. & Russel, P. E. (1958). *Craig and Faust's Clinical Parasitology*, 6th ed., p. 192. Philadelphia: Lea and Febiger.

Khairy, A. E. M., Barakat, R. & Omar, E. (1978). Some aspects of the health status of children of a rural school. Bulletin of the High Institute of Public Health, Alexandria **8**, 219–230.

Mohsen, A. (1978). Environmental Sanitation in rural areas. Paper read at seminar/workshop of *Strengthening Rural Health Services* project, Cairo.