The Introduction of

a New Household Water Storage System

into a Palestinian Village and Its Effect on the

Faecal Pollution of Stored Water

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Summary

A ceramic storage vessel (zir) (1) with a tap attached was introduced into a village using normal tap-less zyar. The faecal water pollution during storage was compared in the old and new zyar by measuring faecal coliform concentrations in the zyar and in the courtyard taps from which the water was collected.

It was found that the introduction of the new zyar had not reduced pollution during storage because, in spite of the attached tap, water was still - just as before - removed from the zir by use of a cup.

It was concluded that a more participative approach to introducing the new idea would have enhanced its chances of success.

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1. Introduction

The pollution of drinking-water during storage in the household has been suggested as a potential route for disease transmission (2), with pollution levels being quantified by faecal coliform concentrations or levels of other indicator bacteria. One difficulty inherent in the study of the effect of storage on pollution arises from the variability of the source quality: the temporal variations in quality of spring or canal water may be large compared with the magnitude of pollution during collection and storage. Hence accurate measurement of the latter can be problematic.

The present study was conducted in Bardala, a Palestinian village of approximately 80 households in the northern Jordan Valley. Every house in the village was provided with a courtyard tap, which was connected to a piped network conducting unchlorinated water from a deep tubewell outside the village.

Every household stored its water in a large 40 litre ceramic vessel (zir) which was filled from the courtyard tap by use of a plastic hose. A plastic or metal cup was used to remove the water from the zir. Bardala was chosen for the study because it was supplied by a consistently clean water source, which could facilitate precise measurement of pollution during storage.

The second objective of the study was to measure the impact of a new method of water storage on pollution during storage. A new type of zir with an attached tap was introduced into the village (see Figure 1). The rationale behind the introduction of this device was that the normal method of water removal from the zir (by use of a cup) could lead to faecal pollution of the stored water if the cup, or the hands holding the cup, were contaminated. If water was removed from the zir through a tap, this risk should be eliminated.

In order to measure faecal contamination, faecal coliforms per 100ml were enumerated. Faecal coliforms per 100ml (FC/100ml) provide an index of the relative magnitude of faecal pollution. There is no agreed level below which water is considered safe other than 0 FC/100ml, which is not attainable in many circumstances. The magnitude of faecal pollution required for the transmission of particular diseases is a complex subject. Present knowledge does not permit the accurate determination of the ratios between faecal coliform and potential pathogen concentrations. Such information, taken together with data on water consumption and infective doses, could provide guidelines for "safe" drinking-water (3). In practical terms, the faecal coliform index is useful for comparing the water quality of

different sources, and for monitoring changes with time. Obviously it is desirable for drinking-water to contain a minimal concentration of faecal coliforms.

2. Methods

20 zyar with taps attached were constructed and transported to the village in December 1984. A list of households was obtained from one of the extended family heads (mukhtar), and households to be given new zyar were selected at random from the list. At this stage a problem arose because the mukhtar refused to allow the new zyar to be distributed to households not belonging to his clan. In view of the fact that opposition of the mukhtar could jeopardise the whole project, it was decided that a biased sample was better than no sample. A random sample was then made from those names which were acceptable to the mukhtar.

Return trips were made to the village in January, April and June 1985. It was intended that 20 zyar with taps attached and 20 traditional zyar would be sampled on each visit. In practice, this proved difficult for two reasons:

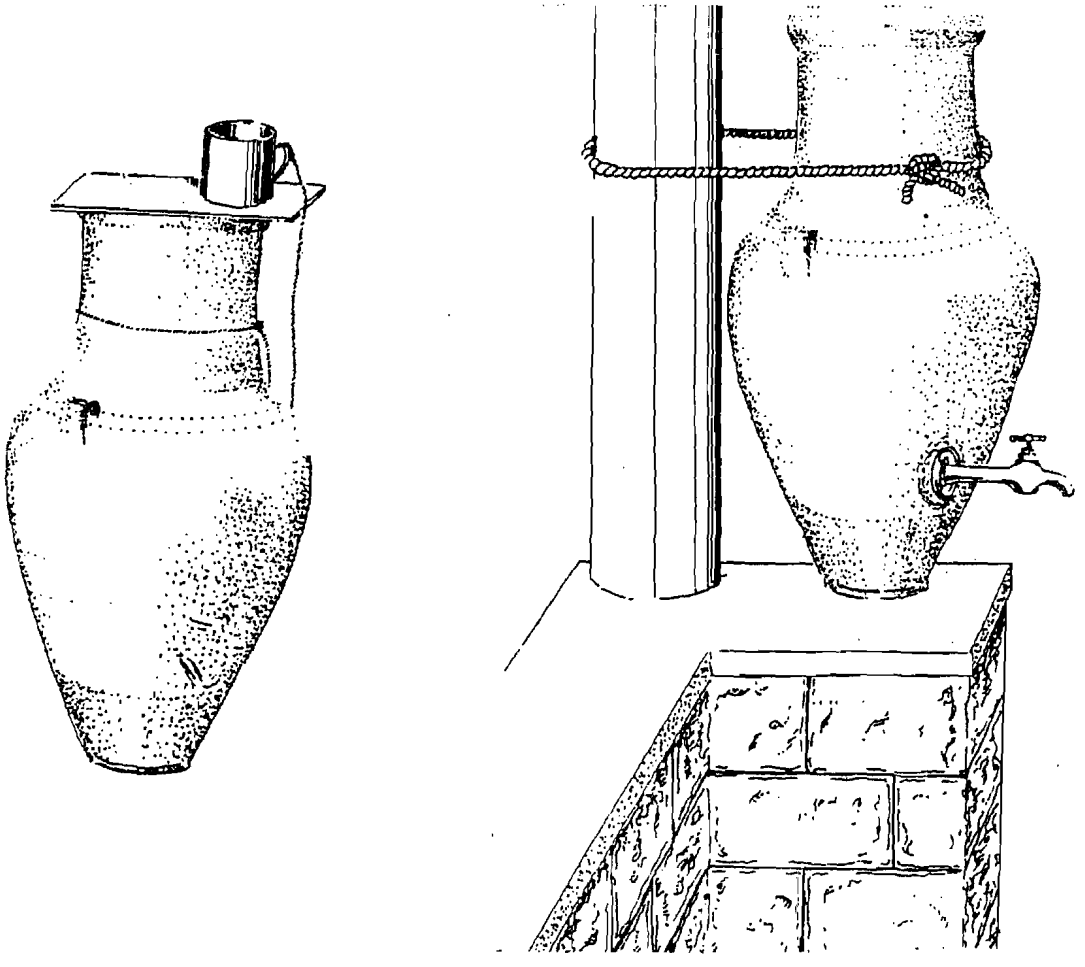
a. Some tap-supplied zyar were not in use, or broken.
b. Access to all the zyar was not possible because some of the residents were out at work.

As a result, an average of only 10 of the new type of zir and seven control households were sampled on each visit. Control households were selected at regular intervals down the village "streets". When no one was at home in the house selected, the nearest occupied household was sampled.

In each household, duplicate samples were taken from the tap and the zir. Tap water was collected in sterile bottles after the nozzle had been flamed and the tap had been left running for one minute (4). A flamed stainless steel scoop was used for collecting water from the zir and decanting it into the bottles.

Samples were transported to the laboratory for analysis within four hours of collection, and faecal coliform concentrations were enumerated by membrane filtration and endobroth incubation at 44.5°C for 24 hours, following standard methods recommended by the American Public Health Association (5). The mean of the two duplicate samples was recorded as the number of faecal coliforms per 100ml (FC/100ml).

Figure 1. Traditional (left) and New (right) Zir



3. Results

The measured faecal coliform concentrations are summarised in Table 1. A total of 54 households were sampled, showing a mean tap water quality of 1.52 FC/100ml and mean zir water quality of 11.09 FC/100ml. This difference was significant at the 5% level.

There was no measurable improvement in the water quality of zyar supplied with taps compared to traditional zyar, with mean qualities of 12.66 and 10.20 FC/100ml respectively. In both cases stored water was significantly different from tap water at the 10%, but not the 5% level.

The study hypotheses and their significance are presented in Table 2. Figures 2 and 3 show the results in graphical form.

Table 1. Summary of Results

Type	Water Quality from Tap			Water Quality from Zir			Difference between Tap and Zir		
	No. of Samples	Mean FC/ 100ml	S.D.*	No. of Samples	Mean FC/ 100ml	S.D.	No. of Samples	Mean FC/ 100ml	S.D.
Zir with tap	31	1.63	3.53	31	12.66	32.67	31	11.06	32.92
Zir without tap	23	1.41	2.75	27**	10.20	15.36	23	7.07	15.88
All house-holds	54	1.52	3.11	58	11.09	25.92	54	9.75	26.72

* S.D.=Standard Deviation

** 4 extra samples were taken from the zyar where the water supply from the tap was temporarily interrupted.

Table 2. Significance of Results

Hypothesis	Test	Result	Significance
1. No significant difference between water quality in tap and tap-supplied zyar.	Paired Students "t" test	t=1.9	Do not reject hypothesis at 5% level. Reject at 10% level.
2. No significant difference between water quality in tap and tap-less zyar.	Paired Students "t" test	t=2.1	Do not reject hypothesis at 5% level. Reject at 10% level.
3. No significant difference between tap and zir water quality in both types of zir.	Difference between means "t" test	t=0.6	Do not reject hypothesis.
4. No significant difference in water quality in zyar and taps in all households.	Paired Students "t" test	t=2.76	Reject hypothesis at 5% level.

Figure 2. Faecal Coliform Concentrations in Households with Tap-Supplied Zyar

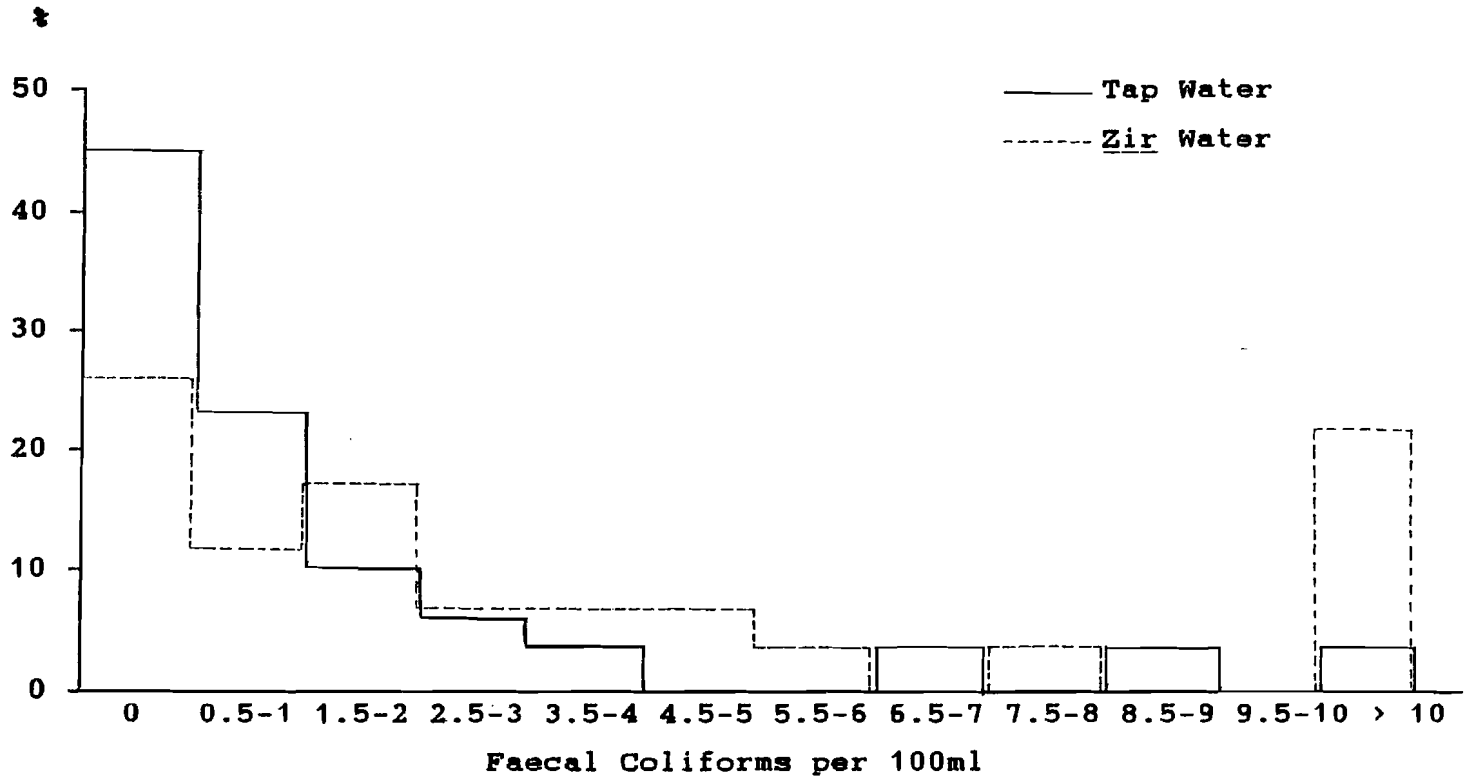
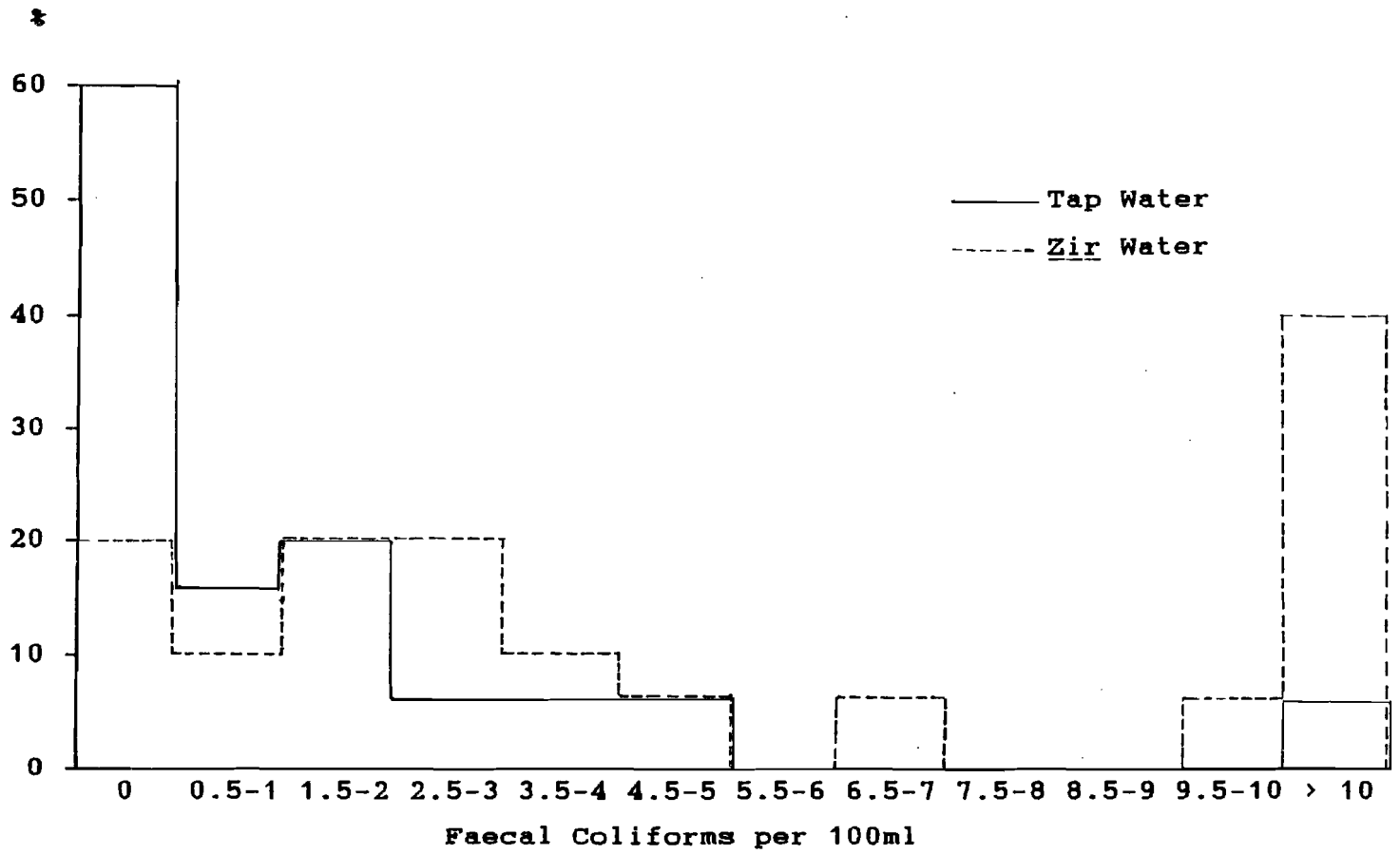


Figure 3. Faecal Coliform Concentrations in Households with Tap-less Zyar



4. Discussion

The outcome of the study revealed that the villagers, who were presented with a new piece of technology as a gift, were, in general, not convinced of its value. Recipients of the new zir made, when interviewed, a variety of complaints, saying that:

- the water tasted bad;
- the water was not cool enough;
- the zir was too small;
- the tap was too loose;
- too much water seeped from the zir;
- the tap was too low to reach, and broke easily.

Many villagers interviewed did not feel that the zir was of particular benefit. They admitted that they used the new zir in the old way, because, according to them, scooping water out with a cup was faster and more convenient than using the tap. In some houses, the zir was secured on a wall or a stand, which rendered the use of the tap more convenient and, at the same time, scooping water more difficult. It was in these houses that the idea seemed to be taken more seriously.

A high breakage rate for the zir also suggested that they were not highly valued by the recipients.

In view of these experiences it was concluded that attempts to introduce a new piece of technology of this kind should involve closer liaison with the community members in the design stage: villagers themselves should be encouraged to participate in the decisions on the size of the zir, the need for a tap, the type of tap, the need for a stand etc. In addition, a health education campaign should accompany the introduction of the zir. Finally, it would perhaps be useful to sell the zir, even at a notional fee, rather than hand it out free of charge, in order to encourage care for the product.

It is thus perhaps not surprising that the water quality in the new zir showed no improvement compared with the old zir. The data presented showed no significant difference between faecal coliform concentrations in the old and the new zir, suggesting that the old practice of scooping water from the zir with a cup was being continued, with the accompanying faecal pollution.

The possible contamination of water by a polluted hosepipe was not measured in the study, and could be a complicating factor.

Many villagers interviewed stated that their water was clean, and since piped water had come to the village in 1967, there had been

few stomach diseases. It is noteworthy that the extent to which drinking-water quality of, say, 10 FC/100ml may pose a risk of disease transmission is not understood; the existing zir system in Bardala may well not be leading to the transmission of intestinal diseases. An extremely detailed and complex epidemiological study would be needed to clarify this issue. Nevertheless, it is clear that, given such uncertainty, it is desirable that drinking-water be as free as possible from faecal contamination.

Notes and References

(1) Plural form: zyar.

(2) Cairncross, S. et al., Evaluation for Village Water Supply Planning, The Hague: International Reference Centre, 1980, p. 73.

Feachem, R. C. et al., Water, Health and Development: An Interdisciplinary Evaluation, London: Tri-Med, 1978.

(3) Feachem et al., op. cit.

(4) Hutton,L.G., Field Testing of Water in Developing Countries, London: Water Research Centre, 1982, pp.10-16.

(5) American Public Health Association, American Water Works Association, Water Pollution Control Federation, Standard Methods for the Examination of Water and Wastewater, 15th, rev. ed., Washington: American Public Health Association, 1981, pp. 814-815.

Bibliography

American Public Health Association, American Water Works Association, Water Pollution Control Federation. Standard Methods for the Examination of Water and Wastewater. 15th, rev. ed. Washington: American Public Health Association, 1980.

Cairncross, S. et al. Evaluation for Village Water Supply Planning. The Hague: International Reference Centre, 1980.

Feachem, R.C. et al. Water, Health and Development: An Interdisciplinary Evaluation. London: Tri-Med, 1978.

Hutton, L. G. Field Testing of Water in Developing Countries. London: Water Research Centre, 1982.