Birzeit University
Community Health Unit

Seasonal Aspects of Faecal Coliform Concentrations in Nine Springs in the Ramallah Area

Occasional Papers

Seasonal Aspects of Faecal Coliform Concentrations in Nine Springs in the Ramallah Area

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Summary

In nine springs which are used for drinking-water faecal coliform concentrations were monitored between May 1984 and April 1985. The results suggested a seasonal trend of higher faecal coliform concentrations in the dry season, and lower concentrations during the rainy season. The hypothesis was proposed that higher flow rates through the aquifer during the rainy season increase the dilution of incoming faecal coliforms from above the aquifer. In view of the fact that the springs are the predominant drinking-water source during the dry season when rainfed cisterns are exhausted, it is noteworthy that this is the period when the springs are most polluted.

1. Introduction

The West Bank of the River Jordan lies west of the Hashamite Kingdom of Jordan and east of the 1967 borders of the State of Israel. According to Israeli sources, 32% of the population (and 50% of the rural population) do not have access to a piped water supply (1).

Most of the villages without a piped supply have access to two kinds of drinking-water sources: rainfed cisterns and springs. The West Bank has an average rainfall of approximately 600mm/year (2). During the rainy season many households use rooftop catchments to collect rainwater, which is then stored in underground cisterns. When the cistern supply is exhausted, water is usually collected from the nearest spring. Other households which do not have access to a cistern use springs throughout the year.

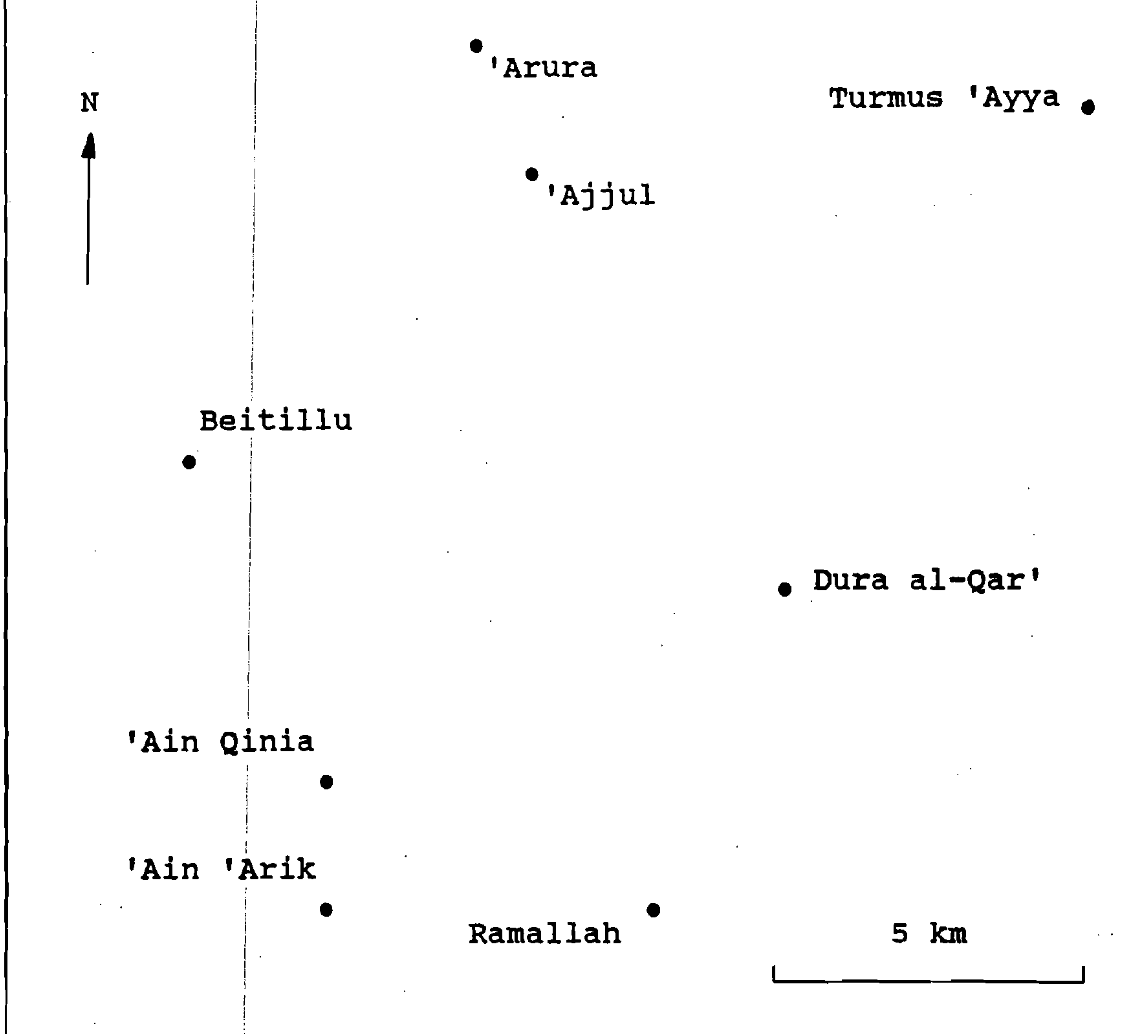
The objective of the study was to monitor seasonal variations in bacterial quality of spring water currently used for drinking in the Ramallah area of the West Bank. The spring locations are shown in Figure 1. In all cases the springs were situated either in the centre or on the outskirts of the village. The geology of the area is fissured limestone. All springs except 'Ain Qinia were protected.

The faecal coliform test applied in this study provides an index of the level of water contamination by faeces of human or animal origin.

Seasonal variations were investigated for two reasons: first, it was of interest for the planning of future epidemiological studies to determine whether a single measurement of spring water quality could be used to generalise over a full year. Secondly, many of the villagers were in a position to make choices about when to use spring water for drinking. Most of the households would tend to use the stored cistern water, which they had collected during the rainy season, until the cisterns were empty. Only then would they collect water from the spring for the remainder of the year. Thus it was of interest to know whether spring water quality between the middle and the end of the dry season was of suitable quality for drinking, or whether it might be desirable to use spring water at a different time of the year.

In 1984/85, the rainy season was from mid-November to mid-April.

Figure 1. Locations of Springs Sampled



The mechanism of spring water contamination by faeces is a complex process involving the interaction of numerous environmental variables. The three most important ones are (3):

1. The rate at which faecal bacteria enter the aquifer supplying the spring;
2. The dilution of incoming bacteria by aquifer water;
3. The rate at which the aquifer purifies the water from faecal bacteria as the contaminated water moves through the aquifer.

During the rainy season the supply of faecal bacteria to the aquifer may be higher due to the increased percolation of water through the overlying rock. The flow rate of water through the aquifer, however, will be higher during the rainy season which, in turn, will tend to increase the dilution of faecal bacteria within the aquifer.

This simple model predicts two possibilities for seasonal variations:

a. During the rainy season spring water will be more polluted due to the increased addition of faecal bacteria to the aquifer which supplies the spring.

b. During the rainy season the increased flow of water through the aquifer will tend to dilute incoming faecal bacteria, and hence reduce their concentration in the spring water.

2. Methods

Prior to collection, bottles were sterilised by autoclaving at 121°C for one hour. Samples were collected in duplicates: the bottles were filled directly from the spring fountain and then transported to the laboratory within 3 hours of collection.

Following the standard method recommended by the American Public Health Association (4), the membrane filtration test for faecal coliforms was performed as follows: 100ml samples from each bottle were tested by incubating filters on endobroth at 44.5°C for 24 hours in a water-jacketed incubator. The temperature at the level of the dishes was measured and was found to conform to the specification of plus or minus 0.2°C.

The number of dark red colonies was counted after 24 hours. Colonies not of the classic E.coli form were confirmed with Enterotubes.

Where colonies were too numerous to count, the result TNTC was recorded, indicating levels above 300 faecal coliforms per 100ml.

3. Results

Table 1. summarises the results of the study, showing the mean number of faecal coliforms per 100ml (FC/100ml) for each spring. The mean is of two samples unless indicated.

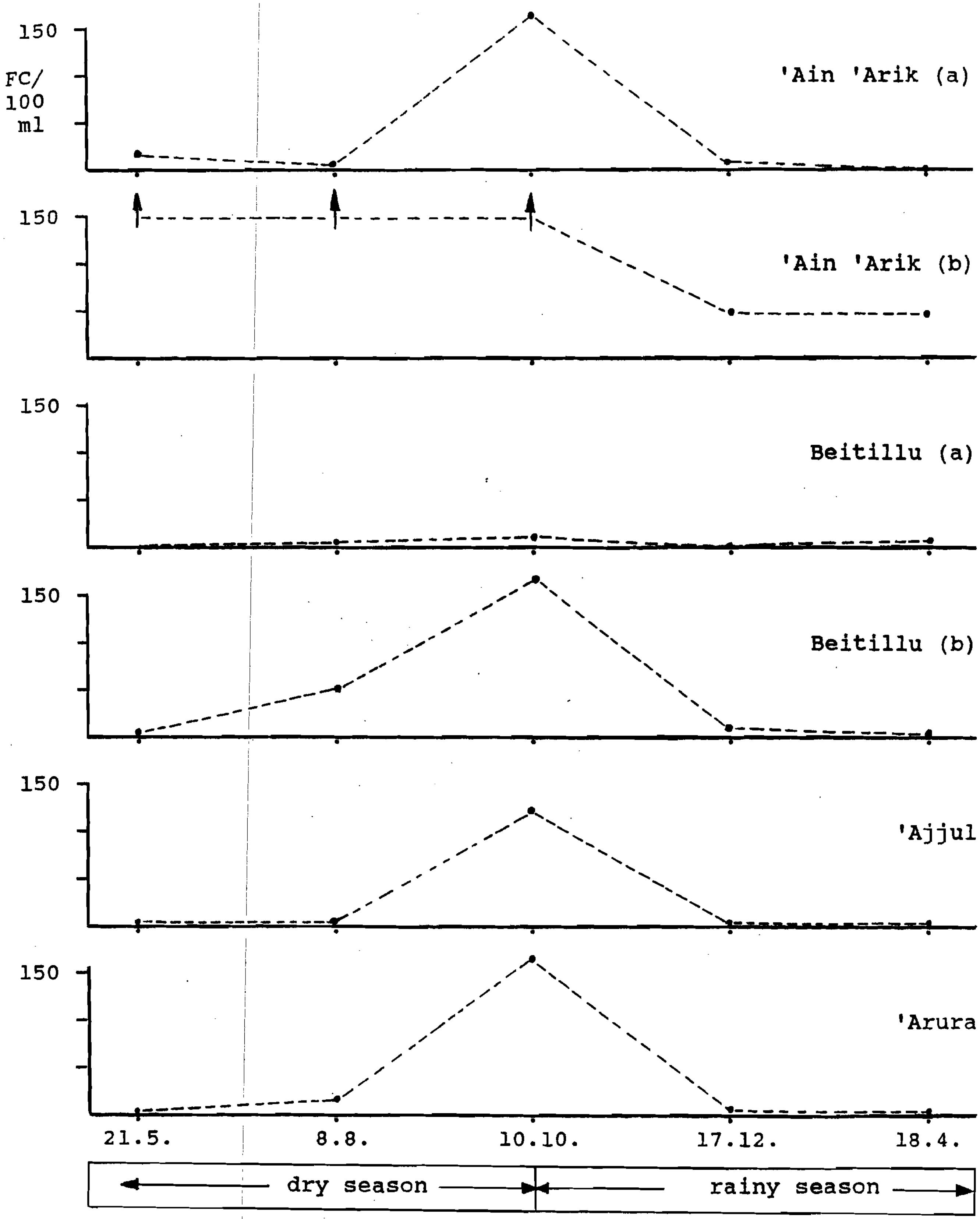
Graphical results for the springs with all 5 sample results are shown in Figure 2.

Table 1. Measured Faecal Coliform Levels by Spring and Date of Collection (Mean of Replicates)

Village		Date				
		21.5.84	8.8.84	10.10.84	17.12.84	18.4.85
'Ain 'Arik	(a)	24	3.5	155	3*	0
	(b)	TNTC	TNTC	TNTC	97*	97
Beitillu	(a)	0	0	2.5	0*	0
	(b)	1.5	80	159	16*	0.5
'Ajjul		0.5	0	107	0*	0
'Arura		0.5	8	TNTC	0.5*	0.5
Dura al-Qar'	(a)	-	0	0	-	0*
	(b)	-	TNTC	88	-	39
Turmus 'Ayya (central spring)		114	TNTC	TNTC	-	-

* denotes mean of 5 samples
TNTC: too numerous to count (usually more than 300 colonies)

Figure 2. Seasonal Variations in Six Springs



4. Conclusion

The results presented in Figure 2 indicate a general seasonal pattern of rising pollution levels during the dry season, and lower levels during the rainy season. This result is consistent with hypothesis b: it confirms that the dilution of incoming faecal bacteria during the rainy season reduces their concentration in the spring water.

In view of the substantial seasonal variations of faecal coliform concentrations in the spring water it can be concluded that single time samples are not adequate to evaluate the springs' bacterial quality.

For the villages concerned, it is noteworthy that they tend to use the spring as a drinking-water source at the very time when faecal pollution of the water is at its highest - towards the end of the dry season.

References

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(3) Lewis, W.J., Foster, S.S.D. and Drasar, B.S., The Risk of Groundwater Pollution by On-Site Sanitation in Developing Countries, IRCWD Report No. 01/82, Duebendorf: IRCWD, 1982.

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

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