

AN INVESTIGATION OF THE POTABILITY OF WATER FROM WELLS IN USE IN THE AREA OF THE KANDY MUNICIPALITY

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Abstract : Samples of water were collected, using standard methods, into sterile containers, for examination for potability from 65 wells scattered throughout the area of the Kandy Municipality. The samples were examined using the MPN method, confirmed with the Eijkmann test, and the total viable (plate) count method. The wells and their environs were also examined; the wells being classified thereby into satisfactory, unsatisfactory and of doubtful status. By these criteria, 20% of the wells examined were physically satisfactory, with 29% unsatisfactory and the rest doubtful. In the examination bacteriologically for potability, only 9% of the wells had water, confirmed to be satisfactory for human consumption. No definite relationship could be established between potability and depth of well and the physical condition of the well as assessed above.

1. Introduction

A majority of Sri Lankans obtain water for domestic use from natural sources such as streams or wells. That such water is often unsafe for human use is demonstrated by the fact that waterborne diarrhoeal disease can be considered to be endemic in all parts of Sri Lanka, and also by the outbreaks of diarrhoeal disease in different localities which are obviously spread by the waterborne route. Further, even though some areas are privileged to have pipeborne, treated water supplies, many Sri Lankans prefer to use natural water sources for some purposes, such as bathing.

There is little literature on the bacteriological quality of water in human use in Sri Lanka. We report here, a survey of the bacteriological quality of well water — in human use — in the area of the Kandy Municipality.

2. Materials and Methods

2.1 Choice of Wells

The area of the Kandy Municipality is well supplied with a pipeborne, trea-

ted water supply. As a result many wells in former use have either been closed or abandoned. There is no available census of wells yet in use in this area, the estimates varying from a few hundred to nearly one thousand. Therefore, in carrying out this study no random sampling technique could be used. Instead wells scattered throughout the Municipality were examined (at random) — a total of 65 wells being thus examined.

2.2 Classification of Wells According to Physical Characteristics

The purpose of describing and classifying the wells was to determine if its location, and physical condition was such that it was in good condition for human use. The characteristics used for this assessment were:

1. The well itself and its condition—whether protected by an adequate wall, whether surrounded by an apron or pavement, whether used and wash water is drained away safely from the well environs, and whether covered or exposed.
2. The environs of the well — particularly in relation to possible sources of contamination e.g. drains, cesspits and soakage pits, marshy lands, etc.

Based on the latter factors — wells were classified into those of satisfactory, doubtful, or unsatisfactory status.

2.3 Collection and Transport of Water Samples

Samples of water, approximately 500ml, were collected using standard techniques.³ Commercially available special containers with a clip on — off type of lid were sterilised and used for water collection, from the deeper part of the well, avoiding surface scum, etc. Samples were collected from deeper wells by lowering the bottle with a sterilised weight attached to the base of the bottle. All specimens of water collected were transported to the examining laboratory, and subjected to examination, within one hour of collection.

2.4 Bacteriological Examination of Water

Bacteriological examination of water was carried out using the (a) presumptive total coliform count method (Most Probable Number method)^{1,2} with suggestive tubes being further examined by use of the (b) Eijkmann test or confirmed test.^{1,3} Briefly the methodology of examination for coliform bacteria was as follows: MacConkey's fluid medium (double and single strength) was prepared and sterilised in different quantities in appropriate containers, (bottles and tubes): each containing a Durham tube for indicating gas production. The water to be examined was added to the medium as follows:

- (a) one 50 ml quantity to 50 ml of double strength medium,
- (b) five 10 ml quantities, each to 10 ml of double strength medium,
- (c) five 01 ml quantities, each to 05 ml single strength medium and
- (d) five 0.1 ml quantities, each to 05 ml of single strength medium.

The containers of medium were then incubated for 24 to 48 h at 37°C, and those showing acid and gas production considered positive. The combinations of positives and negatives were then used, with reference to a MacCreedy's probability tables, to indicate the probable number of coliform organisms in the sample of water. Those bottles or tubes showing acid and gas were then subcultured into five ml tubes of Brilliant Green bile broth, and incubated in a water bath at 44°C for 24h. Those showing gas production and turbidity were considered positive, and a computation of the number of *Escherichia coli* for 100ml was made as before from MacCreedy's probability tables. At the same time a total viable bacterial count of the water samples was performed by the use of the pour plate method with Nutrient agar the incubation temperature being 35°C.

2.5 The Criteria Used for the Interpretation of the Bacteriological Analysis

These criteria used were recommended by the World Health Organisation.⁴ Thus, for untreated ground water supplies, there should be no faecal coliforms, while the occasional finding of 10 coliform organisms or less per 100ml, was allowed.

3. Results

The purpose of the description of the wells was to determine if the well was located satisfactorily and in good physical condition for human use. Based on the criteria described above it was found that of the 65 wells examined only 13 (20%) were satisfactory, while 19(29%) were unsatisfactory, and the rest of doubtful status.

The results of the bacteriological analysis of well water for coliform organisms and *E. coli* is presented as a bivariate frequency distribution in Table 1. All samples of water tested yielded coliform bacteria; and *E. coli* were not found only in six. Thus only 9% of the wells had a satisfactory bacteriological water quality on this examination, using the World Health Organisation's criteria for the evaluation of potability.⁴

Table 1. Probable counts of coliform bacteria and *Escherichia coli* in well water in Kandy.

Probable count	of <i>E. coli</i> from Eijkmann test						Total number of wells
	0	1-10	11-50	51-100	101-500	501-1000 or more	
0							
1-10	3	11					14
11-50	1	4	5				10
51-100		1	1	2			4
101-500		5	7				12
501-1000	1				2	5	8
1001-or-more	1	3	5	1	2	4	17
Total number of wells	6	24	18	3	4	9	65

Range of counts of total coliforms (presumptive count) — 4 to > 1800/100ml and *E. coli* — 0 to 1600/100ml.

The result of the potability analysis was then compared with the physical condition of the well as determined above. This data is presented in Table 2. It is seen that on this occasion no relationship could be established, of the status of the well as determined by physical conditions, and the bacteriological quality of its water *vis a vis* its suitability for human use. Among wells examined, many were shallow and a few deeper. The potability of water in relation to the surface level of water (its depth from the surface) is also presented in Table 2. The data here too suggests no trend of the relationship of the quality of water with depth.

The total counts of viable bacteria in the water examined, ranged upto 51,000 per 100 ml. The distribution of viable counts in relation to the coliform counts are presented in Table 3.

Table 2. Bacteriological quality of water from wells, in relation to physical status, and depth.

Results of water analysis		Depth of wells						Total number of wells	
		≤ 1m	> 1-2m	> 2-3m	> 3-4m	> 4-6m	> 6m		Depth not known
Not potable	M	3	2	4	1		2	12	
	E	4	2	4	1		2	13	
Satisfactory potable	M	1						1	
	E								
Physical status of wells Doubtful	Not potable	M	8	7	6	2	1	1	25
	E	7	9	7	1	1	1	2	28
potable	M		5	2			1		8
	E	1	2	1	1				5
Not satisfactory	Not potable	M	3	4	5		1	1	15
	E	3	6	4	1	1	1	2	18
potable	M		2	1	1				4
	E			1					1

M – Result with presumptive coliform count method

E – Result with Eijkmann test (*E. coli* count)

Table 3. The relationship between the total viable bacterial count of water and the presumptive coliform count

Type of bacterial count	Total viable count						
	0-100	100-1000	1000-10000	10000-25000	25000-50000	50000-75000	
< 10	3	4	2	2			
10-100		5	6	5	1		
100-1000		1	10	3	4	1	
> 1000			1	8	6		

Presumptive coliform count

4. Discussion

The important finding here is that a large proportion of wells in use in a major urban area in Sri Lanka are unsatisfactory for human use. The causes for the unsuitability of the well water in this investigation are not obviously clear. Kandy is a densely built up area with houses built in close proximity to each other. The sewage disposal systems used here are the cesspit, or septic tank/soakage pit systems, with each house having its own system located within the borders of its garden itself, the latter often being of small extent. Thus, the well would be quite close to the latter. Further, wells tend to be sited at the lowest location on a slope, and often there are many houses with their sewage systems located at higher levels than the well. It could thus give rise to a situation where effluent from the residences at higher elevations flow down to the well situated further down. An additional factor may be that, when wells are dug (the water table in Kandy, excepting on the slopes, being usually high), they are often quite shallow, allowing easier seepage of surface water into the well without adequate filtration through soil layers. Also, many shallow wells have the upper water levels at almost ground surface level, and such wells often have one side not built up, and unprotected by a wall, (for convenience of access to the water), allowing water to be splashed from outside in to the well, permitting contamination.

The vast majority of people in this country use wells as drinking water sources, particularly in rural areas, and do not have access to pipeborne, and treated water supplies. Therefore a large scale survey of the potability of well water in use in the country becomes urgently necessary. This would be a first step for formulating measures for the provision of safe water for the masses. This could also be a necessary first step from the point of view of considering measures for the prevention of water borne diseases.

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