INTRODUCTION

Although it is enshrined as a human right, the provision of adequate potable water remains a major problem in most developing countries (Hurst et al., 2003). Deaths due to water-related diseases add up to more than 3 million people per year (WHO, 2003a). Infectious diarrhea alone claimed 1.7 million lives in 2002 (WHO, 2003b). The relationship of disease to water is clearly established and the mechanisms that link different diseases to water have been well described (Feachem, 1975). Most water-related diseases occur in large outbreaks that sometimes assume epidemic proportions. The Broad street cholera episode in London, remains a classical case (Snow, 1856). Outbreaks of typhoid, cholera, and other water-related diseases still occur in endemic areas of Nigeria (Mohammed and Chikwem, 1992; Banwat et al., 2003).

The World Health Organization has guidelines for drinking water quality which provide for inspection, surveillance and protection of community supplies (WHO, 1997). Several communities in Nigeria exist without water supplies of good quality and quantity. Despite this situation, successive governments have tended to ignore the problem and laid more emphasis on non-health-related programs.

It is to highlight some of these water supply problems that this study was initiated. The water supplies to two rural communities 7-8 km north of Calabar, Cross River State of Nigeria, were examined bacteriologically using standard indicator bacteria (coliforms and streptococci). A contiguous community supplied with treated piped water was also studied in parallel. The water supplied to these communities was examined bacteriologically using standard indicator bacteria (coliforms and streptococci). The geometric mean bacterial counts per 100 ml of serial samples from six sources ranged from $0.12 \times 10^1$ to $1.57 \times 10^2$ for fecal coliforms ($E. coli$) and $0.05 \times 10^1$ to $7.5 \times 10^1$ for the fecal streptococci. Fecal streptococci were particularly recovered in large numbers from one source (Ayip Asikimangfuk) at concentrations of up to $3.0 \times 10^2$ per 100 ml at the onset of the rains. The water supplies from the community with piped water were, in general, bacteriologically satisfactory; fecal coliforms were found only in occasional samples ($0.12 \times 10^1/100$ ml).

MATERIALS AND METHODS

Sample collection

Samples were collected in 500 ml sterile flasks from water sources serving six communities in two large villages along the Calabar-Ikom road. These were Ikot Effanga Mkpa (population, 4,500) and Ikot Omin (population, 3,000), 7 and 8 km, respectively, north of Calabar, the Cross River State Capital. Calabar itself is located at $4^s57'N$ and $8^v19'E$. The water supplies were the Idim Agriculture and Idim Ekpu, untreated shallow streams; the Ayip Ikeng, Ayip Asikimangfuk, Ayip Ebarense and the Ayip Efugho springs.
which issue from the base of hills and settle in muddy unsanitary narrow valleys. Piped, treated water was obtained from taps serving an indigenous community adjoining the University of Calabar campus. All samples were collected with sampling precautions (APHA, 1985) and returned to the laboratory and tested within 1 hour.

**Bacteriological analyses and cultures**

Water samples were examined by membrane filtration techniques using a Millipore Sterifil system with membrane filters (pore size 0.45 \( \mu \)m) and pads, where appropriate. The membrane enriched Triton agar (0.2TX) (Opara et al, 1977) was used for the total and thermotolerant coliform (E. coli) counts. Slanetz and Bartley (S&B) agar (OXOID) was used for the enumeration of fecal streptococci. Cultural methods, incubation conditions of media, as well as the identification and confirmation of indicator bacteria, were carried out as recommended in Report 71 (1969) and/or APHA (1985).

**RESULTS**

Table 1 shows the geometric mean counts of the total coliforms, E. coli and fecal streptococci per 100 ml of water, obtained from serial samples taken from seven sources. Six samples were taken from each source: three during the dry season and three at the onset of the rains. All the samples from the piped waters were bacteriologically satisfactory and complied with international standards for drinking water set by the World Health Organization (WHO, 1993). Fecal coliforms were obtained only in occasional samples. The untreated rural waters consistently contained total coliforms and thermotolerant E. coli at concentrations well above recommended standards. The geometric mean counts per 100 ml of serial samples from the six sources ranged from 0.12x10^1 to 1.57x10^2 for the fecal coliforms (E. coli) and 0.05x10^1 to 7.5x10^1 for the fecal streptococci. The highest mean counts of E. coli were obtained from the Idim Ekpu, shallow unprotected brown water. Fecal streptococci and total coliforms were recovered in the highest mean numbers from the Ayip Asikimangfuk water, a percolated muddy source. The mean bacterial counts were 7.5x10^1 and 5.5x10^3 for fecal streptococci and total coliforms, respectively. The terminal values in the ranges of bacterial counts were obtained at the onset of the rains. They were higher than the counts taken in the dry months.

**DISCUSSION**

The water supplies available to the rural communities were small slow-flowing streams,
springs or stagnant water. They were found to be bacteriologically unfit for human consumption, their content of indicator organisms being at levels higher than the recommended international standards. They were also esthetically unsatisfactory. Their location and surrounding environment undoubtedly contributed to their poor quality. Some of these water sources received direct human and animal excrement. The high recovery of fecal streptococci from these sources confirms their contamination from animal sources. This is in agreement with the fecal coliform: fecal streptococci ratios proposed by Feachem (1975). They also served as drinking, bathing and other recreational sources. The spring sources flowed from rock bases or holes dug at the foot of hills. While the original outflow of water from these areas appeared clean, they were secondarily contaminated by the surrounding soil, the body contact of users and dirty containers. This kind of secondary contamination has been documented (Han, 1989; Molbak et al, 1989; Hurst et al, 2003). All these waters received no further treatment before being drunk. Samples of rural water supplies taken at the beginning of the rains, yielded higher bacterial loads than those sampled during dry days. This is expected, since the rural supplies were unprotected and received soil run-off whenever it rained. The bacteriology results confirm the alarming environmental contamination of these sources. As expected, the treated and piped water supplies complied with the international water guidelines. Only occasional samples yielded indicator organisms.

This study highlights the alarming water supply problems encountered by rural communities around Calabar. They depend, all year round, on rural water, the bacteriological contents of which are below acceptable standards. It also reveals the contrasting amenities available to communities living contiguous to each other; one provided with piped and treated water, the others dependent on rural sources only. The full impact of this contrasting situation will form part of the second installment of this article.

ACKNOWLEDGEMENTS

The author acknowledges the financial support of the University of Calabar, through the Senate Research Grant.

REFERENCES


