ASSESSMENT OF MICROBIOLOGICAL QUALITY OF UNTREATED DRINKING WATER AT OMDURMAN PROVINCE, SUDAN

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ABSTRACT
Assessment of drinking water quality at West Omdurman was the main objective of this study. The west region of Omdurman province was selected as an area of study for its high population density and as an important animal trade center. Three water samples from each of eight sites at west Omdurman were taken for bacteriological analysis using the faecal coliform Most Probable Number (MPN) and the Total Viable Count (TVC) methods. Obtained data was analyzed statistically against standard values for public water supplies. The study revealed that four sites were compatible with the acceptable standard faecal MPN figures. One site, which was El Sheik Abuzaid, was found to be extremely polluted. The other three remaining sites revealed the presence of faecal coliform at a significant and alarming level. All sites exhibited high TVC reflecting the bad technical quality of water therein. Recommendations were made to use chlorination in all sites and to check and cease all malpractices of using ground water tables as sites for sanitation systems disposals. The study emphasized the need for assessment of drinking water in Sudan at large.

INTRODUCTION
Clean water supplies are essential to the welfare and health of human and animal. Unhygienic water contributes to the transmission of many diseases to human and livestock. The contamination of natural water with faecal material from sewage and agricultural runoff may result in an increased risk of disease transmission to humans (Geldreich, 1991; Wiggins, 1996). Diarrheal disease problems from contaminated water represent a serious hazard in developing countries and chronic one in developed countries (Grant, 1997). Human pathogenic microorganisms that are transmitted by water include bacteria (enterobacteriaceae, Vibrio), viruses (hepatitis A), and protozoa Guardia sp. (Brendan, 1975; Lewis, 1985). Most of these microorganisms usually grow in the human intestinal tract and reach to outside in the faeces. Faecal coliforms have been seen as an indicator of faecal contamination (LeChavallier et al., 1996) and are commonly used to express microbiological quality of water and as a parameter to estimate disease risk (WHO, 1984; Bartram and Wheeler, 1993, WHO, 1993). Most Probable Number (MPN) is a typical test for faecal coliform based on lactose fermentation using elevated temperatures and different medium formulations as described by the American Public Health Association (1995).

To our knowledge, no specific study has been done to assess microbiological quality of ground water resources at Omdurman (Sudan). Some studies (Abdel Magid et al., 1984) have been done to detect the microbiological quality of Nile water in some other parts of the Sudan. Sources of drinking water at Omdurman are chiefly ground sources, the majority of which are untreated. The aim of this study was to examine
ground water sources at West Omdurman to estimate potential risk by detecting faecal pollution namely the faecal coliforms. The study was also aimed to raise the awareness of the people, animal owners and officials about the importance of microbiological examination of apparently clean water supplies.

MATERIALS AND METHODS

Study Area: West Omdurman area was selected as the study area because it is one of the major animal collection and trade points. It is also one of the most human populated areas in Sudan. Eight sites were selected for samples collection. The names of these sites were: El Sheik Abuzaid, Almwaileh, Mamoun project, Aameria, Central abattoir, Almarkhiat, Khalid Project and Ganawa.

Sample Collection: Three samples were taken from each site making the total number of sample 24. All samples were collected in sterile 250 cc metal closed glass bottles. At the site of collection water was allowed to run for 5 minutes before taking the sample. Samples were transported in black plastic bags containing ice and brought promptly to the laboratory within 1-2 h, then kept in refrigerator at 4°C. Samples were examined within 18h of collection.

Faecal Coliforms Enumeration: Analytical methods for bacteriological analysis were performed according to standard tests (Cox, 1973; WHO, 1984). Number of Faecal coliforms per 100cc water was estimated by the MPN method. 10 ml, 1 ml, and 0.1 ml water portions were planted in MacConkey–lactose-bile-broth and incubated at 37°C for 48 hr. Tubes showing acid and gas were subculture in brilliant-green-lactose-bile broth at 37°C for 48 hr. Tubes showing acid and gas in the last step were then subcultured in MacConkey lactose-bile-broth at 44.5°C for 48 hr. Tubes showing acid and gas at 44.5°C in the water bath were recorded as faecal coliforms positive. The presumptive MPN counts of the faecal coliforms in 100 cc water were estimated from the published tables (Cox, 1973) considering, the number of positive tubes in the water bath.

Total Viable Count: Analytical methods for the bacteriological examination were performed according to the Standard Plate Count (Cox, 1973) with some modifications. Nutrient agar medium was used for plate counting. One ml of water from each sample was diluted to $10^{-1}$, $10^{-2}$, $10^{-3}$ and $10^{-4}$. Water from the site under investigation was used as diluents after been sterilized in autoclave at 121°C under 15 lb atmospheric pressure for 15 minutes. Such diluents provided the same environment, in which the targeted bacteria live and constitute no harm.

Statistical Analysis: The statistical analysis of the difference between one site means MPN and control was tested using the t-test. Control in this regard was the faecal coliform MPN/100 ml water accepted locally in Sudan for drinking water (Abdel Magid et al., 1984). Also the t-test was used to test the statistical significance of a difference between each site mean total viable count/ml, and control. In this context the control was the minimum total viable count/ml accepted locally for drinking water.

RESULTS

Growth on Different Media: Samples number 7, 8 and 9 from Mammon project and sample number 18 from Almarkhiat showed no growth when inoculated in MacConkey–lactose-bile broth at 37°C for 48 hr. All other 20 samples in the study showed growth when planted in the same media at 37°C for 48 hr. Different tubes of all samples that showed
acid and gas in MacConkey-lactose-bile broth at 37°C for 48 hr gave positive results when planted in Brilliant green--lactose--bile broth at 37°C for 48 hr with the exception of tube number 4 from sample 16. Tube number 7 from sample 3, tube number 1 from sample 14, tube number 3 from sample 14, tube number 5 from sample 22, tube 6 from sample 22, tube 5 from sample 23, tube 7 from sample 23, and tube 5 from sample 24 didn’t give acid and gas when subculture in MacConkey lactose-bile broth at 44.5°C in water bath for 48 hr.

**Total viable count:** The results of the TVC per ml are shown in (Fig. 1). The TVC in all samples were found to range between $3.4 \times 10^4$ and $1.53 \times 10^6$. The lowest viable count recorded was $3.4 \times 10^4$ in sample 13 from Omdurman Central Abattoir whereas the highest one which was $1.53 \times 10^6$ was recorded in sample 2 from Elshiekh Abuzaid. Samples 4, 5, 6, 7, 8, 9, 13, 14, and 15 showed viable counts less than $1 \times 10^5$. Six samples showed viable counts more than $5 \times 10^5$. Six samples showed viable counts between $1 \times 10^5$ and $5 \times 10^5$. Only sample Number 13, 14 and 15 from Omdurman Central Abattoir and sample Number 9 from Mamoun project showed viable counts less than $5 \times 10^4$. Nine samples showed viable counts less than $1 \times 10^5$.

![Fig. (1): Mean Total Viable Count /ml at of Drinking Water at Different Sites of West](image)

**Faecal Coliform MPN:** The results of the faecal coliform MPN/100ml water are shown in (Fig. 2). The lowest faecal coliform MPN/100ml water recorded was zero, which was obtained from sample 7, 8, and 9 from Mamoun project and sample number 18 from Almarkhia. The highest faecal coliform MPN/100ml water recorded was 2400/100ml obtained from the three samples of Elshiekh Abuzaid. Three samples showed faecal coliform MPN/100ml water ranging between 20 and 27 all recorded in site 8 at Ganawa. Fourteen samples showed MPN between 2 to 5/100 ml water.
Fig. (2): Faecal Coliform MPN /100ml Water at Different Sites of Western Omdurman

Statistics: The differences between each site mean faecal MPN and acceptable (standard) MPN at 5% level of significance indicated that no difference was observed between estimates of faecal MPN at site 3, 4, 5, or 6 and the standard value of faecal MPN. No significant (p< 0.05) difference was observed between the mean MPN of site 2 and the standard value of faecal MPN. Estimates of mean MPN of site 1, 7 and 8 recorded a significant difference from the standard MPN value. All viable count means at different sites were very much extreme than standard viable count/ml. Thus providing strong evidence against any proposed null hypothesis (hypothesis of no difference).

DISCUSSION

The presence of faecal coliform in drinking water in seven sites at western Omdurman was indicative of faecal contamination at these sites. An MPN of 200 count/100 ml water is considered an important criterion to define faecal pollution of water (Feresa and Sickle, 1990; Sargaonkar and Deshpande, 2002). Accordingly, Elshiekh Abuzaid area in the western region of Omdurman province can be described as heavily polluted with faecal coliforms. Other sites are described as polluted with faecal coliform and others having acceptable water for human utilization as revealed from the results of the present study.

The multiple tube technique used in this study, although very sensitive, informative and indicative of faecal pollution magnitude, but it was time consuming and required much glassware and materials. The rapid membrane filter technique would be very practical if a large-scale water analysis program is to be launched at Omdurman area at large. The two media used in this study, MacConkey broth and Brilliant green broth, usually have variable composition for their peptone and bile salts contents (Feresa and Sickle, 1990), and this could affect results obtained when such media are used. This implies the need for standardization of such media used for such purpose.

The production of acid (change in colour) and gas observed due to growth of coliforms on both media used at both temperatures 37°C and 44.5°C, was satisfactorily
identifying criterion for faecal coliforms and no identification of colonies on solid media was needed (Bartram and Wheeler, 1993).

The conventional viable count technique used in this study does not provide suitable conditions for anaerobic bacteria to grow. So the TVC reflects only counts of aerobic bacteria.

The faecal pollution is considered a problem of surface water quality in most countries. The present study consolidates previous studies in Sudan that ground water resources are increasingly suffering from faecal pollution (Abdel Magid et al., 1984). The area of Western Omdurman approximately obtains all its water needs from ground water. The ground water resources in Omdurman are being increasingly endangered by disposals of sanitation systems. Analysis of water in Sheik Abuzaid revealed results, which were indicative of bad water quality there in and the possible potential risks for both human and animal health. Two public sanitation system facilities were observed near to Elshiekh Abuzaid. These might be the reason behind the high MPN observed in that site.

All wells analyzed in this study were tube wells and none was a dug–well. They were all equipped with distribution systems composed mainly of upper tanks and pipe Lines. The high viable counts obtained in all sites of the study probably reflect the large amounts of nutrients present in water due to the poor maintenance of the distribution system and also reflect the lack of chlorine-ation. The variation in results among different sites may provide evidence that each site well of those studied drills separate source of ground water.

Further water analysis programs are needed at representative drinking water sites not only in Omdurman but in Sudan at large to assess the exact magnitude of ground water pollution with faecal matters, and to alert people and animal owners of the potential health hazard. The results of this study evoke alarm that damage to such valuable sources is likely to take place.

The present study concluded that some sites at western Omdurman were compatible with public water supplies standards relative to faecal pollution (acceptable). Three sites were considered polluted, while one site was found to be heavily polluted with faecal matters. All site at the area of study exhibited high TVC.

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REFERENCES


