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Effectiveness of home water treatment methods in Dschang, Cameroon

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ABSTRACT

The MPN (Most Probable Number) technique was used to assess the bacteriological quality of nine of the important drinking water sources in Dschang. Water from the most polluted source was then subjected to six home-based treatment methods, commonly used by the population. Boiling for up to thirty minutes was the most effective method. This was followed in decreasing effectiveness by chemical methods using sodium hypochlorite and chloramines, filtration techniques with the use of the porcelain candle, micro filter and cotton filter. In order to have water of acceptable quality, the sanitary techniques of boiling and the use of sodium hypochlorite and chloramines are recommended.

Key Words: bacteriological quality, treatment methods, drinking water, quality.

RESUME

La technique du NPP (Nombre le plus probable) a été utilisée pour évaluer la qualité bactériologique de neuf importantes sources d'approvisionnement en eau de boisson à Dschang. L'eau la plus polluée a été par la suite traitée par six méthodes couramment utilisées par les populations. Il en ressort que l'ébullition de l'eau pendant 30 minutes est la méthode la plus effective. Ceci a été suivi dans l'ordre décroissant par les traitements chimiques à base d'hypochlorite de sodium et de chloramine, et les techniques de filtration avec la bougie de porcelaine, le micro-filtre et le coton. Afin d'avoir une eau de bonne qualité, les techniques sanitaires d'ébullition et l'usage d'hypochlorite de sodium et de chloramine sont recommandés.

Mots-clés: qualité bactériologique, méthode de traitement, eau de boisson, qualité.

INTRODUCTION

The earth is considered a wet planet with about 70 % of it composed of water, yet this water is unevenly distributed and of variable quality. Salt water makes up 97.2 % of this and only 2.8 % is freshwater [1]. Much of this available freshwater is inaccessible to humans, even with the latest technological advancement. Though clean freshwater was once considered inexhaustible, it has now dawned on humans that this is not the case and that there is need to preserve this valuable resource. Global water concern has been the subject of many international seminars and conferences, from the International Hydrological Decade launched in 1965 to the International year of freshwater in 2003 and high on the latter's agenda was the need to equitably distribute the world's water resources. Prior to this in the year 2000, the United Nations established the Millennium Development Goals for the reduction of poverty, hunger, child and maternal mortality, incidence of major diseases and for improved environmental stability by the year 2015 [2]. Achieving these goals requires sustainable economic and social development in developing countries. However, most of the constraints to development are increasingly tied to water [2]. Although only one of the millennium goals directly relates to water, improved water management can make a significant contribution to achieving most of the other goals. Inadequate supply of water has therefore been identified as one of the central causes of poverty in developing countries as it affects their basic needs, health, food security and basic livelihoods. Much of this sustainable development therefore focuses on getting people out of poverty, and improved access to adequate and safe water has been shown to make a major contribution towards poverty alleviation worldwide. Today 1.1 billion people do not have access to safe drinking water while 2.4 billion people lack basic sanitation facilities. This has led to over 2.2 million deaths yearly from diseases directly related

to drinking contaminated water [3]. About 90 % of these severe water problems occur in developing countries where inadequate access to water leads to other crisis such as tensions and conflicts.

It is estimated that in Cameroon, water related diseases accoun for about two-thirds of all recorded diseases and are responsible for 50 % of all reported cases of death [3]. In 1991, 12.6 % of children died before the age of five mainly due to water related diseases. This proportion increased to 15 % in the year 2000. A major cause for this was due to the deteriorating water quality in both rural and urban centres.

There has been a rapid increase in the population of Dschang town since the creation of the university of Dschang in 1993, and the expansion of services has not kept pace with the increasing population. This has led to inadequate sanitation facilities and water supply infrastructure resulting in repeated water shortages and interruptions. When pipe borne water flows, its aesthetic quality is poor, as such, about 83 % of the population turn to alternative sources which they consider to be potable [4]. The important water sources used by the population are the piped chlorinated system, a mini distribution system at the periphery of the town supplied from a borehole, a market well, and six urban springs.

From previous studies carried out in Dschang, it was concluded that much is still desired on the amelioration of the microbiological quality of drinking water [5]. Presently there is no national water quality guideline but we have used other established water quality standards [6, 7]. Some segments of the population recognize that the water quality from most of the sources used for domestic purposes is poor. As a result various methods are used at home in a bid to render the water potable [8]. The objective of this study was to determine the effectiveness of six home treatment methods on the bacteriological quality of polluted water from urban springs in Dschang so as to recommend the most suitable.

MATERIALS AND METHODS

Dschang is located in the west province of Cameroon and has a population of about 81,700 [9]. It is located between latitude 5°25N and longitude 10°04E in the Western Highlands of Cameroon at an altitude range of between 1200-1400 m. Dschang has a sub equatorial type of climate characterised by four months of dry season starting from mid November to mid March and eight months of rainy season from mid March to mid November, with an annual average rainfall of between 1200-1800 mm. The average daily temperature is 20.9 °C and the average daily humidity ranges from 33 to 98 %.

Water samples were collected in clean glass bottles sterilised in a hot air oven at 160 °C for 2 hours. They were transported in an ice chest to the laboratory for analysis. Faecal coliform concentrations of water from all the sources were determined to ascertain the most polluted water source. Water from this most polluted source was subjected to the six home-based treatment methods that are commonly used by the population [4, 8]. These treatment methods were:

(i) Heating: 500 ml of polluted water was boiled for 30 minutes in a clean sterile container, and was allowed to cool to room temperature and then 100 ml was used for bacteriological analysis.

(ii) Home made cotton filter: This was made by packing cotton in a sterile frustum having a circumference of 30 cm and a height of 27 cm. Cotton was packed to a height of 16 cm using a sterile glass rod. The frustum was placed over a sterile collecting vessel where 1000 ml of the polluted water was filtered. One hundred ml of the filtrate was drawn off for analysis.

(iii) Micro filter: 1000 ml of the water was filtered in a micro filter and then 100 ml of the filtrate was analysed.

(iv) A Candle filter having a porcelain candle was used to filter the water and 100 ml of the filtrate was analysed.

(v) Sodium hypochlorite (NaClO): 10 litres of the water was allowed to react for 30 minutes with a drop of sodium hypochlorite [7]. However, [10] recommends 1 litre of sodium hypochlorite to 265 litres of water. This implies 1 drop (0.05 ml) to 13 litres of water.

(vi) Chloramine tablets: these are compounds formed by the reaction of *p*-sulfonamidobenzoic acid and an excess of sodium hypochlorite. The addition of

hydrochloric acid or acetic acid also results in the precipitation of the sodium dichloroisocyanurate as the main reaction product. One hundred mg of the chloramine tablet was dissolved in 5 litres of water and allowed for 30 minutes. Then 100 ml was drawn out for analysis.

Bacteriological analyses were carried out in accordance with the WHO standards [7]. A 100 ml water sample of each source was distributed into five 10 ml and one 50 ml amount in sterile bottles containing Mc Conkey broth of purple colour. The bottles were incubated at 44 °C in a water bath for 24 hours. The bottles which indicated acid and gas production were counted. Reference was made to probability tables where the most probable number of *E. coli* colonies in 100 ml water sample was estimated.

The mean MNP of the sample from each treatment method was compared to the original count of the most polluted source to obtain the effectiveness of the treatment

RESULTS

The results obtained from the bacteriological analysis of the nine different water sources are presented in table 1. From this result it was found that the Pentagon spring was the most polluted spring source with an *E. coli* count of 30.88 per 100 ml. The results of the bacteriological analysis of the water from the Pentagon spring subjected to the six treatments are presented in table 2. The effectiveness of the treatment methods are presented in figure 1.

Table 1: *E. coli* count of the different sources of drinking water.

Sample origin	Nature of source	Mean count
Piped chlorinated system	Treated surface water	8.25
Mini distribution system	Borehole	21.0
Market	Protected well	8.67
California	Spring	9.38
Pentagon	Spring	30.88
Foto	Spring	13.5
Gendarmerie	Spring	15.63
Madagascar	Spring	9.75
Foreke	Spring	9.14

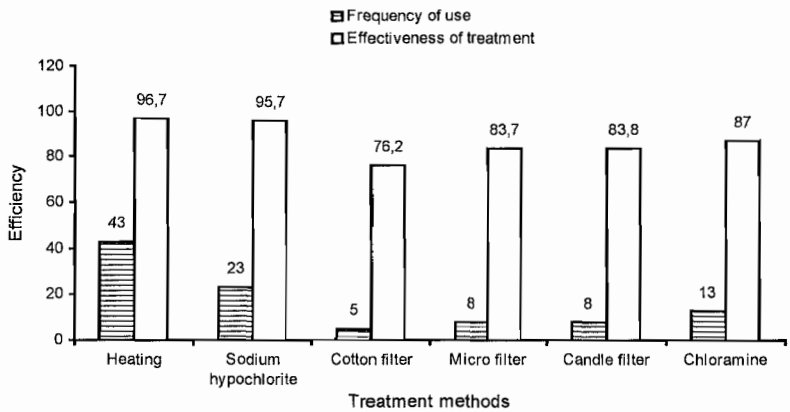

Figure 1: Effectiveness of treatment methods and frequency of use

Table 2: *E. coli* count of water from 6 home water treatment methods

Method	*E. coli* count per 100 ml water
	Average
Heating for 30 minutes	1
Cotton filter	16
Micro filter	6
Candle filter	5
Sodium hypochlorite (NaClO)	2
Chloramine Tablets (NaDCC)	3

DISCUSSION

Heating the Pentagon spring water for up to 30 minutes proved to be the most effective method (96.7 %) among the home water treatment methods used. The boiling process inactivated the bacteria such that upon sampling using the MPN method only 1 count of coliforms per 100 ml was detected.

The use of sodium hypochlorite was the second most effective with 95.7 %. The sodium hypochlorite penetrates the resistant surfaces of microorganisms destroying them [11]. The sodium hypochlorite dissociates into hypochlorous acid and the chlorate ion, which are called free residual chlorine. Since the hypochlorous acid is about one hundred times more germicidal than the chlorite ion, it is preferable that in water there should be the preponderance of this acid. This is usually at the pH 6 and the spring waters of Dschang have a pH range of between 5.32 and 6.12 [5]. The disinfecting efficiency of various compounds of the halogen series with reference to some target organisms has been documented [12]. In this classification, the hypochlorous acid had a high relative efficiency against enteric bacteria and viruses, bacterial viruses and protozoan cyst. For optimum efficiency, the water temperature was between 5 and 25 °C, and the pH between 6 and 7.5. The use of chloramines tablets was the third most effective method with an effectiveness of 87 %. In water, this tablet dissolves quickly to release chlorine gas and hypochlorous acid, an active ingredient having biocidal activity against bacteria and viruses [11].

The candle filter was 83.8 % effective and proved the best among the filters. Next was the micro filter with 83.7 % effectiveness and the least effective was the use of the cotton filter 76.2 %. The filtration is made possible as a result of the porous nature of the medium where water passes through and some organisms and other particles are trapped. The pore spaces in the porcelain filter is much smaller allowing bacteria to pass through and increases through the micro filter to the cotton filter which has larger spaces, thus allowing much of the bacteria to pass through.

A limited survey carried out in Dschang acknowledged that only 26 % of the different water sources of doubtful quality were treated by the population [4]. Of this percentage of treatment, spring water is 63 %, well water is 23 %, pipe borne water is 11 % and stream water is 1.5 %.

Since a good portion of the town is not served by the piped chlorinated system, alternative sources of water have therefore become important in supplying the drinking water needs of the town to the tune of about 83 %. This often requires that water be hauled for distances not less than 200 m usually in containers that are not permanently covered. Considering that socio-culturally mostly women and children fetch water, the likelihood of contamination is high. From the statistics of the prevalence of water borne diseases obtained from the Dschang district hospital, gastro enteritis is responsible for over 75 % of reported cases of water borne diseases [8]. This disease is caused by a serotype of *E. coli* called enteropathogenic *Escherichia coli* (EPEC) [11]. Other water borne diseases also recorded include typhoid and paratyphoid with a prevalence of 15 % and amoebic dysentery having a prevalence of 10 %. We can infer from this

statistic that home potable water management is poor despite the fact that about 66 % of those who treat water use the two best methods.

The use of home-based water treatment methods is very important for alternate water sources to meet acceptable drinking water norms. The results that are presented here were obtained from a laboratory with very stringent handling procedures, which may be absent in day-to-day normal water handling techniques at home. Heating the water for up to thirty minutes is the best home based water treatment method. This is followed by the use of chemicals of which sodium hypochlorite proved to be better than chloramines to disinfect water. Filtration techniques followed where the porcelain candle was the most effective, followed by the micro filter and the cotton filter being the least effective. Therefore in most homes, it is recommended that those responsible for handling drinking water follow prescribed sanitation techniques of boiling and using chemicals such as sodium hypochlorite and chloramines in order to have water of acceptable quality. The Pentagon spring water is very unfit for drinking and hence it is not advisable that this spring be used for family drinking water needs without proper treatment.

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