CHEMICAL AND MICROBIOLOGICAL ASSAY OF SOME WATER SAMPLES IN SOUTH WEST NIGERIA

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ABSTRACT

Some diseases are known to be transmitted through contaminated water. So the World Health Organisation has set standards on water wholesomeness for various uses. Samples of three different brands of packaged water, and from the Sagamu Water Works (just before passage into the pipeline and at the domestic tap) were chemically and microbiologically analysed using established methods. Results of the various chemical assays indicated acceptable limits set by the WHO for alkalinity, nitrate, silica and chloride. However, the results of microbiological assay showed that water from domestic tap contained several coliform organisms including *Escherichia coli* contrary to the WHO requirement that it should be coliform-free.

INTRODUCTION

Access to adequate "safe quality" water by all peoples is important to their health and well-being. About 80% of all diseases and over a third of deaths in developing countries are caused by the consumption of mainly microbially and chemically contaminated water.[1] The risk of acquiring water-borne infection is known to escalate with the level of contamination by pathogenic microorganisms while factors such as the infectious dose and host susceptibility moderate the relationship. *Salmonella typhis, Vibro cholera, Giardia lambia* and hepatitis A virus are frequently transmitted via polluted water.

The World Health Organisation (WHO) has published guidelines on drinking water in 'The WHO Standard For Portable Water'.[2] The guidelines states the limit of amount of any constituent in drinking water that does not result in any significant health risk to the consumer over a lifetime.[1] The microbiological quality of drinking water is of the greatest importance, and must never be compromised. Water for drinking and for all usual domestic purposes is expected to be free from any microorganisms known to be pathogenic or any bacteria indicative of faecal pollution. More acute diseases resulting from chemical contamination of small community supplies have been reported to include methaemoglobinaemia in infants due to high levels of nitrate and toxicosis due to accidental and other discharges of solvents and heavy metals from mining activities.[3]

The present work was carried out in order to determine the quality and suitability for drinking of some water sources in and around Sagamu, Ogun State of Nigeria.

MATERIALS AND METHODS

Collection of Samples

Water samples for both chemical and physical assay were collected into freshly washed, air-dried plastic containers, tightly covered, appropriately labeled, and kept at low temperature before analysis. Samples for microbiological assay were collected into sterile, widemouthed bottles with dustproof ground glass stopper and used immediately. Three different brands of packaged water in sachet, purchased at various selling points in Sagamu, and samples of water from the public water supply, just before passage into pipeline at the treatment plant and from domestic tap were used for the experiment.

Chemical Analysis

Total alkalinity of each sample was determined by titrating 0.02N H_2SO_4 against 50ml of the sample, to which had been added a drop of 0.1N sodium thiosulphate. Methyl orange (two drops) was used as indicator to detect the end-point when the mixture changed from orange to pink color.

Estimation of the nitrogen (nitrate) content: 25ml of each sample was taken and evaporated to dryness in an evaporating dish on a water bath. To the residue was added phenol disulphonic acid (2ml) and mixed thoroughly using a glass rod. After addition of few drops of water, 50% NaOH solution was added drop wise until a permanent intense yellow colour developed. The mixture was then emptied into Nessleriser tube and volume made up to the 50ml mark with distilled water. The tube was then placed in Lovibond comparator and a nitrate disk used to estimate the quantity of nitrate in the sample.

Estimation of silica content: 50ml of each sample was taken into a conical flask, and 1ml 1NHCl and 2ml ammonium molybdate were added in rapid succession. The mixture was then thoroughly mixed and allowed to stand for five minutes, and then 1.5ml of oxalic acid was added with stirring. The colour of the resulting mixture was read visually using a Lovibond comparator.

Estimation of chloride content: 50mls of each sample against standard silver nitrate solution at pH between 7-10. For samples with pH value less than 7, the pH was first adjusted with 1N NaOH. About 1ml of potassium chromate indicator was added before the titration.

Bacteriological Analysis of the Water Samples

Nutrient Agar Plate Count: For each sample, 1ml was pipetted into molten nutrient agar at 45°C. The mixture was thoroughly mixed and the plate incubated at 57°C for 48h. The numbers of colonies of bacteria that developed and were visible under a magnifying glass were counted to determine the plate counts.[4]

Most Probable Number: The Most Probable Number (MPN) method was used

to determine the number of coliform organisms per 100ml of each sample. Series of sterile bottles containing MacConkey broth purple and Durham tubes were inoculated with different quantities of each sample and incubated at 37°C for 48h. Each tube was examined for gas formation.

Differential Coliform Test: Samples with positive result from MPN were sub-cultured separately into 10ml Brilliant-Green-Bile-2% broth-containing Durham tube and incubated at 44°C for 48h. Coliform bacteria number in 100ml of the original sample was estimated by making reference to the McCradys probability table.

RESULTS AND DISCUSSION

The results of turbidity tests indicated that all the samples tested gave turbidity level 5 Nephelometric turbidity units (NTU). High level of turbidity has been known to protect microbes from the effect of disinfections, stimulate bacteria growth and exert a significant chlorine demand. However, the value for all samples were far below the WHO limit 15NTU for colour in drinking water. The combined perception of substances detected by the senses of taste and smell is often called "taste" which represents the largest single class of consumer complaints in drinking water supplies. Water should be free of objectionable taste and odour. The WHO guideline criterion is "not offensive" for most consumers. [6] This was the case in all the five samples investigated.

The pH measurements gave 6.80+0.01, 7.00+0.01, 6.80+0.01, 7.20+0.01 and 7.20+0.01 for Sample A, B, C, D and E respectively, all clearly within limits of the WHO maximum permissible values of 6.5-9.2. The pH is the negative logarithm of the hydrogen ion concentration. Low pH associated with high acidity in water is known to contribute to the corrosiveness of water. However the results showed that alkalinity was not a problem with the waters produced in the area under study.

The results obtained for determination of silica content were 12.00+0.01, 6.00+0.01, 20.00+0.02, 8.00+0.01 and 8.00+0.01mg/l for A, B, C, D and E respectively. Many natural water sources contain less than 10mg/l of silica, though some may approach 60mg/l, which is usually in soluble forms. The results indicated that only two of the samples which gave values greater 10mg/l but less than the permissible limit 45mg/ml.

The determination of chloride ion concentration gave 5.60+0.01, 4.50+0.01, 3.70+0.01, 5.00+0.01 and 3.96+0.01mg/l for A, B, C, D and E respectively, far below the 200mg/l guideline value stipulated.[5] Chloride is one of the major anions in water and is largely responsible for the salty taste. Water containing more than 250 mg/l Cl ions may produce detectable salty taste with sodium ions. The phenomenon is however, absent with concentrations of 100 mg/l and below. Also, high chloride content in water is found to exert deleterious effects on metallic pipe structures and plants.

The concentrations of nitrate for Samples A, B, C, D and E considered were 5.00+0.01, 3.00+0.01, 2.20+0.01, 5.00+0.01 and 5.00+0.02 mg/l respectively. High levels of nitrates is reported to contribute to infant methaemoglobinemia.[3] A limit of 45mg/l has accordingly been imposed on drinking water as a means of averting this condition. The nitrate concentrations of most drinking waters usually fall below 10mg/l. All the samples contained less than the specified limit and hence passed the test.

The results of the microbiological assays are presented in Table 2. The NAPC test showed that Samples B and E were bacteria-free; A and C showed 2 and 1 colonies respectively; and D showed numerous colonies. The results implied that the latter samples contained bacteria. The results of MPN tests indicated that only Sample D contained 14 coliform of organisms/100ml, which was further confirmed by the DCT as *Escherichia coli.* (gas formation within 48h) The NAPC at 37°C is an indication of the number of bacteria which thrive at body temperature and which therefore includes those of faecal origin. On the other hand, MPN Count at 37°C indicates the number of bacteria in the coli-aerogenes group while DCT at 44°C is estimation of the numbers of *E. coli* present, which is a positive indication of the degree of faecal pollution or contamination. The result for D was a positive indication of the degree of possible faecal pollution.

A greater majority of water quality problems in the underdeveloped world are known to be related to microbial contamination, though serious health hazards may also occur due to chemical contamination of water sources from industrial and/or agricultural activities or natural. In most cases, measurement of a selected number of physicochemical parameters is enough to establish existing contamination problems.[5]

Generally, where community water supplies are unchlorinated, they will inevitably contain large numbers of total coliform bacteria, which may be of limited sanitary significance. It is therefore recommended that the bacteriological classification scheme should be based on thermotolerant (faecal) coliform bacteria or *E. coli.* However, where piped small-community water supplies are being analysed and samples are taken at various points in the system, water quality may differ in different parts of the system at any one time. Again the reasons for this may become obvious during the sanitary inspection or if these differences are the result of cross-contamination or contamination caused by leaks in pipework after resampling. It is common to use 95% compliance criteria when assessing the results of microbiological analysis. This procedure is appropriate only where adequate numbers of samples are analysed for statistical purposes and is not generally applicable to small-community water supplies.[6]

CONCLUSION

The results of the physical and chemical tests carried out showed that all the samples complied with the requirements of the WHO. However, microbiological analysis of the samples showed that the samples obtained from domestic tap contained *E. coli.* The contamination might have occurred as the water passed through pipes with leaks some of which may not be observable. It might be advisable to further treat the water from this source; boiling and filtration on a micro scale would do.

Table 1. Determination of the Amount of Constituents in selected Water Samples

Sample	Constituent			
	Alkalinity pH	Nitrate mg/l	Silica mg/l	Chloride mg/l
A	6.80+0.01	5.00+0.01	12.00+0.01	5.60+0.01
B	7.00+0.01	3.00+0.01	6.00+0.01	4.50+0.01
C	6.80+0.01	2.20+0.01	20.00+0.02	3.70+0.01
D	7.20+0.01	5.00+0.01	8.00+0.01	5.00+0.01
E	7.20+0.01	5.00+0.02	8.00+0.01	3.96+0.01
WHO Limit	6.50-9.20	45 mg/l	45mg/l	200mg/l

Table 2: Determination of Water Safety by Microbiological Assays.

Sample	Assay		
	NAPC	MPN	DCT
A	2	Nil	Nil
B	Nil	Nil	Nil
C	1	Nil	Nil
D	Numerous	14	14
E	Nil	Nil	Nil
WHO Limited	Nil	Nil	Nil

* **Key**

NAPC Nutrient Agar Plate Count
MPN Most Probably Number
DCT Differential Coliform Test

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