PHYSICOCHEMICAL AND MYCOLOGICAL QUALITY OF A DRINKING WATER

O. Obire[1], W.N. Barade[2], Ramesh.R.Putheti[3]

Department of Applied and Environmental Biology, Rivers State University of Science and Technology, P.M.B. 5080, Port Harcourt, Nigeria, email: omokaro515@yahoo.com

[3]*A membern in sigma Xi, The scientific research society,E.mail:rutwikusa@yahoo.com.*

Abstract: A total of 98 drinking water samples were collected during a seven-month investigation from Omuihuechi stream near Port Harcourt, Nigeria. The water samples were analyzed for physicochemical parameters and mycoflora to determine the water quality. The mean values of temperature, pH, dissolved oxygen (DO) and biological oxygen demand (BOD_5), transparency, total organic carbon, chloride, sulphate and phosphate were 25.2°C, 5.1, 8.4mg/L, 6.4mgL, 189.0cm, 13.0mg/L, 4.0mg/L, 7.8mg/L, and 0.24mg/L respectively. Among the seven heavy metals detected in the water samples, cadmium and lead concentrations were higher than the WHO guidelines for drinking water. The mean value of total fungal count was 11.3 x 10^2cfu/mL and the fungal genera isolated were; *Aspergillus, Byssochlamys, Candida, Cephalosporium, Cladosporium, Fusarium, Mucor, Penicillium, Rhizopus, Saccharomyces, Sporobolomyces, and Trichoderma.* Presence of heavy metals and fungal genera which contain potential pathogenic species indicate that the water of Omuihuechi stream is not safe for drinking and for other domestic purposes.

Keywords: Drinking water, heavy metals, fungi, pathogens.

Introduction

Surface waters including rivers, streams, lakes, ponds, etc. are sources of water for drinking and for other domestic purposes. However, these surface waters are easily contaminated by runoffs and wastes generated from human activities. Majority of the population in the Niger Delta, Nigeria including Port Harcourt and its environs are not supplied with potable water and are left to use unsafe water for drinking and other domestic purposes. The Omuihuechi forest stream in Umuihuechi village of Aluu near Port Harcourt is a tributary of the New Calabar River located in Rivers State of Nigeria [1]. The river is one of the major rivers within the Niger Delta region of Nigeria. It is used as routes and harbor for boats and barges of oil and oil servicing companies. The river receives contaminants and wastes generated from industrial, agricultural and domestic activities. The Omuihuechi stream is about 600m from the area of industrial activities on the New Calabar River at Choba town. The inhabitants of Umuihuechi village whose population is over 2000 consume the raw stream water without any form of treatment.

Majority of the diseases in developing countries today are infectious diseases caused by bacteria, viruses and other microbes which are shed in human faeces and pollute waters which people use for drinking or washing. Water supplies used for human consumption must be free from organisms and from concentration of chemical substances that may be hazardous to health [2]. Microbiological quality standards for most natural water sources are based on faecal coliform count. The most widely used faecal coliform indicator is *Escherichia coli* [*E. coli*] from human and animal wastes [3]. Fungi are also disease-causing agents but have been neglected in water quality determinations.

No water quality investigation or study has been carried out on the Omuihuechi raw stream water that is consumed raw without any form of treatment. Thus there is the need to ascertain the water quality of Omuihuechi stream as regards potability. The research is therefore designed to investigate some physico-chemical parameters including presence of heavy metals and the mycoflora of the raw stream water. The objectives of the study therefore are to determine values of some of the physicochemical constituents including heavy metals of the Omuihuechi stream water; to isolate, enumerate and identify the types of fungi present and their relative frequencies.

Materials and Methods

Sampling Station and Collection of Water Samples

The sampling station is the point from which the inhabitants of Umuihuechi village in Aluu collect their drinking water. It is located about 50m upstream beyond the point where the inhabitants carry out their domestic activities and is 'believed' to be free from any domestic or industrial activities. On the other hand, the station is about 600m from the area of concentrated industrial activities on the New Calabar River.

Water samples were collected from a depth of about 25-30cm from drinking water station for physico-chemical analyses, Dissolved Oxygen (DO) and biological oxygen demand (BOD_5) determinations, heavy metal analyses and mycological (fungal) analyses. Samples were collected bi-weekly for a period of seven months. A total of 98 drinking water samples were collected during the investigation.

Determination of Physicochemical Parameters and Heavy Metals

The following physico-chemical parameters - water temperature, transparency, pH, chloride, sulphate and phosphate, DO, BOD_5, total organic carbon (TOC), and oil and grease were determined according to the standard methods of the American public health association (APHA) [4]. The pH was measured by the use of automatic digital pH meter (Model METTLE DELTA-340) made in England. The decline in DO was measured using a Polarographic Oxygen Meter (YSI-model 54ARC Ohio USA). Heavy metal concentrations were detected using SHIMADZU-AA-6300 atomic absorption flame emission spectro-photometer (AAFES). The analyzed heavy metals were copper, chromium, iron, nickel, zinc, cadmium and lead.

Fungal Cultivation, Enumeration, Characterization and Identification

Czapek Dox Agar was prepared in accordance with the modification of Czapek solution by Smith [5] in agar. A 0.1ml aliquot of 10^{-1} dilution was plated onto agar plates and incubated at 27.5^{o}C in an inverted position for 5 days. The discrete colonies that developed were counted and the means of replicate plates were recorded. Fungal cultures were observed while still on plates and after wet mount in lacto-phenol on slides under the compound microscope. Observed characteristics were recorded and compared with the established identification key of Malloch [6,16].

Results

The average range and mean in parenthesis of the physico-chemical parameters determined and fungal counts of water samples of the drinking water station of the Omuihuechi stream are as shown in Table 1.

Table 1: Average range and mean values of physicochemical parameters (mg/L) and fungal counts of raw stream drinking water samples

PARAMETER	RANGE & MEAN VALUES OF WATER SAMPLES
Temperature (°C)	23.7 – 27.6 (25.2)
pH	4.84 – 5.31 (5.1)
Transparency (cm)	160 - 200 (189.0)
Dissolved oxygen (mg/L)	6.8 – 11.9 (8.4)
BOD_5 (mg/L)	4.3 – 8.6 (6.4)
Total organic carbon (mg/L)	12.4 – 14.2 (13.0)
Oil and grease(mg/L)	Not detected
Chloride (mg/L)	3.8 – 4.2 (4.0)
Sulphate (mg/L)	6.4 – 8.6 (7.8)
Phosphate (mg/L)	0.18 – 0.31 (0.24)
Fungal count (x10^2cfu/mL)	7 -14 (11.3)

The heavy metals determined and their mean values in parenthesis are; cadmium (44.2μg/L), copper (63.2μg/L), chromium (38.6μg/L), iron (197.6μg/L), lead (29.2μg/L), nickel (10.7μg/L) and zinc (14.5μg/L).

The fungal genera and frequency of isolation (in parenthesis) from the drinking water samples were; *Aspergillus* (4.75%), *Byssochlamys* (2.37%), *Candida* (13.65%), *Cephalosporium* (2.92%), *Cladosporium* (3.56%), *Fusarium* (4.75%), *Mucor* (2.37%), *Penicillium* (18.76%), *Rhizopus* (5.93%), *Saccharomyces* (22.55%), *Sporobolomyces* (13.65%), *and Trichoderma* (4.75%).

Discussion

The present study has revealed values of some physico-chemical constituents (including heavy metals), and mycoflora (fungi) of the raw Omuihuechi stream water that is consumed raw without any form of treatment. Generally, the pH range is acidic and the values of DO, BOD_5, and the heavy metals are far higher than the WHO guidelines for drinking water [7,15].

Concentration of dissolved oxygen is one of the major limiting factors for mineralization of organic matters in a river. The high DO content of the Omuihuechi stream may have accounted for the high fungal counts recorded in this study.

Cadmium and lead concentrations recorded for the water samples are quite high for drinking water. Occurrence of cadmium, chromium, iron and lead may be associated with the industrial activities in the oil servicing company which include the use of anti corrosion paints and paints of various kinds. The high concentration of iron (>100μgL^{-1}) is significant because low pH concentrations may cause iron toxicity [8]. High levels of sulphates may also lead to increased release of soluble reduced metal species (e.g. Fe, Zn, and Cu), from sediment into surface water thereby increasing their availability. The pH of the stream is acidic and this is attributed to the industrial activities along the New Calabar River. Sulphuric acid is believed to be a major acid component of deposition in most industrialized regions. Effects of acidification of natural waters include changes in biological species composition and densities and changes in biogeochemical cycling of a number of elements. In this study, the mean total fungal counts recorded are considered very high ranging from 7.0 x 10^2cfu/mL to 14.0 x 10^2cfu/mL and the acidic pH of the water might have contributed to the proliferation of fungi. The high fungal count is also an indication of gross contamination of the stream.

High isolation frequencies of the yeasts (*Candida, Saccharomyces* and *Sporobolomyces*) may be attributed to the palmwine tapping activities around the drinking water station while the overall high incidence of fungi is probably linked to the domestic activities and decomposing organic matters around the station.

Most of the fungal genera isolated from the water samples are known to contain species that are potential pathogens or opportunistic pathogens. The main hazardous species belong to *Aspergillus, Penicillium, Cladosporium, Mucor,* and *Fusarium* that have been implicated in being causative agents in asthma, hypersensitivity pneumonitis and pulmonary mycosis. Some diseases caused by these fungi in humans are aspergillosis, liver tumor, fungal balls in the lungs, chronic productive cough and haemoptysis, bronchial asthma, infection of the ear or paranasal sinuses, fungal cells within histiocytes, necrosis and eventual abscess formation, multiple brain abscesses and Verucose dermatitis, a chronic human mycosis. Others include rhinocerebral mucormycosis, infection of the nasal turbates and paranasal sinuses spreading rapidly to the eyes and brain; necrosis and thrombosis and invasive mucormycosis [9].

The high occurrence of *candida* in the water is of considerable concern as the genera can cause candidiasis of the skin in persons on broad-spectrum antibiotic therapy [9]. Members of the genus can also produce endocarditis, septicemia, protracted urinary tract infections, kidney and lung infections, esophagitis, oral thrush, diaper rash infections in infants, vaginal infection in women and other soft tissues infections [9]. Fungi are also implicated in Dermatomycoses, a superficial fungal infection that penetrates only the epidermis, hair, or nails. Such infections include athlete's foot, jock itch, and ringworm [10, 11,15]. Pathogenicity of some fungi is not as a result of their numbers but in the production of mycotoxins. Most of the isolates in this investigation produce mycotoxins.

Fusarium species are common plant pathogens and causative agents of superficial and systemic infections in humans [12,16]. *Fusarium* spp. produces mycotoxins. Ingestion of grains contaminated with these toxins may give rise to allergic symptoms or be carcinogenic in long-term consumption [13]. In a study of waterborne nosocomial infections, the existence of Fusarium in hospital water distribution system was implicated in the observed disseminated Fusariosis in immunosuppressed patients [14]. It is worthy of note that the Omuihuechi stream serves as a source of water for many domestic purposes such as food processing of various grains including maize used in producing palp (*akamu*).

The presence of these potential fungal pathogens is of considerable concern as regards public health. The presence of the heavy metals and of the fungi that are potential pathogens is an indication that the Omuihuechi raw water is not safe for drinking, food processing and for other domestic use.

Conclusion and Recommendation

The study determined some physicochemical properties (including heavy metals) and occurrence of fungi in the Omuihuechi stream water. Presence of the heavy metals are probably due to the industrial activities carried out along the bank of the New Calabar river. Heavy metal toxicity may be induced if the levels are left unchecked. On the other hand, the presence of fungi is attributed to domestic activities on the stream. Unfortunately, most of the fungi reported in this study are potential pathogens capable of causing chronic illnesses in humans upon ingestion of contaminated water or food.

Owing to the health hazards associated with the fungi isolated from the drinking water used for this study, it is important that the stream water be properly and adequately treated before consumption. Since domestic activities and tapping of palmwine may be leading to the fungal contamination of the stream, the adoption, practice, and maintenance of good personal hygiene as regards human activities on the stream is warranted. There is the urgent need for companies sited along the river to treat their wastewater effluents before disposing into the river. This will ensure a better water quality of the stream. The maintenance of high personal and environmental hygiene as well as proper treatment and disinfection of the stream water will improve the water quality and prevent water-borne diseases. Potable water should be provided for the communities to prevent the use of the raw water for consumption, food processing, domestic, recreation, and other purposes.

References

[1] Erondu ES, Chinda AC (1991). Variations in the physico-chemcial features and phytoplankton of the New Calabar River at Aluu, Rivers State Nigeria. *Nigerian Institute for Oceanography and Marine research (NIOMR)*, 1991.Technical. Paper No. 75.

[2] Sloat S, Conol Z. “The use of Indicator organism to Assess Public Water Safety”. HACH Technical Center for Applied Analytical Chemistry. Colorado, 1991. pp 1-20.

[3] World Health Organization. *“Guidelines for Drinking Water supply; Microbiological aspects”.* WHO publications Geneva, 1980.

[4] APHA. *Standard Methods for the Examination of water and wastewater, 20th edition.* American Public Health Association, American Water Works Association and Water Environment Federation, USA, 1998.

[5] Smith G. *An Introduction to Industrial Mycology*. Edward Arnold Publishers Ltd., London, 1971. Pp 277

[6] Malloch D. *Moulds Isolation, Cultivation and Identification,* Department of Botany University of Toronto, Toronto Canada, 1997.

[7] World Health Organization. *“Guidelines for drinking water quality: Recommendations”.* WHO Publications, Geneva, 2004; **1**: 30

[8] Brain M. *Ecology of Fresh Waters.* Blackwell Scientific Publication. London, 1993; 10-59.

[9] Singleton P, Sainsbury D. *Dictionary of Microbiology and Molecular Biology. 3rd Edition.* John Wiley and Sons Ltd. New York, 2001; 895p.

[10] Romano C, Miracco C, Difonzo EM. Skin and nail infection due to *Fusarium oxysporum* in Tuscany, Italy. *Mycoses*. 1998; **41** : 433-437

[11] Deshpande SD, Koppikar GV. A study of mycotic keratitis in Mumbia. *Indian Journal of Pathogenic Microbiology* 1999; **42** : 81-7

[12] Mayayo E, Pujol I, Guarro J. Experimental pathogenicity of four opportunist *Fusarium* species in a murine model. *Journal of Medical Microbiology* 1999; **48** : 363 - 366

[13] Schaafsma AW, Nicol RW, Savard ME, Sinha RC, Reid LM, Rottinghaus G. Analysis of Fusarium toxins in maize and wheat using thin layer chromatography. *Mycopathologia* 1998; **142** : 107-13

[14] Squier C, Yu VL, Scout JE. Water borne nosocomial infections. *Current Infections Disease Report* 2000; **2** : 490 – 496.

[15] Ramesh .R.Putheti, Okigbo R.N."The role of probiotics in reducing the environmental pollution" http://www.sigmaxi.org/programs/issues/Putheti_Okigbo.pdf.

[16] Obire ,O,Ramesh .R.Putheti, Dick.A.A, and Okigbo R.N."Biotechnology influence for the production of ethyl alcohol (ethanol) from waste fruits'e-JST, 2008; issue 9 vol;3; 17-32