BACTERIOLOGICAL ASSESSMENT OF WATER FILTRATION UNITS OF INDUSTRIES IN IJEBU ODE MUNICIPALITY

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H. O. Egberongbe, H. A. Adekola*, J. Biolkat, O. A. Banjo and F. M. Oyeyipo
Department of Microbiology, Olabisi Onabanjo University, PMB 2002, Ago-Iwoye, Ogun State, Nigeria
*Corresponding author: haderinsayor@gmail.com

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Abstract: Water filtration is one of the oldest water treatmentprocedure used in eliminating pathogenic bacteria during water treatment in industries. This study aimed to assess the microbial load of water filtration units used in industries. Swab sticks were used for filter bed screening and samples were also obtained for raw and filtered water. Standard procedures were employed to perform microbial analysis of the samples.The raw water and sample swab microbial count ranges were 48 to 208 cfu/ml and 178 to 298 cfu/ml, respectively. Bacteria species isolated in this study were *Klebsiella pneumoniae*, *Staphylococcus aureus*, *Pseudomonas aureus*, *Enterobacter* sp. *Escherichia coli*and *Chomobacterium violaceum*. No bacteria growth was observed in the filtered water samples. Water filtration units should be continuously assessed to affirm the quality of water used for production.

Keywords: Bacteria, filtration unit, industry, microbial load, water, water filtration

Introduction

Water is used predominantly for the manufacturing and processing of products in industries (Haijoubi *et al*., 2017). It is also very vital for the maintenance of aseptic and hygienic industrial environment (Lucas *et al*., 2017). While there is no pure water in nature due to consistent presence of pollutants, microbiological risks associated with water can be minimized by providing enhanced integrity of prevention of bacteria through water purification processes, which allows requirements quality standards to be met particularly during storage and internal distribution (Fujioka *et al*., 2019; Khutia *et al*., 2010).

The American Society for Testing and Materials International (ASTM) classifies highly filtered water into three types; ultrapure, reagent grade and bio-application grade, based on its unique characteristics and usage of the produced water (Proctor *et al*., 2015). Ultrapure water is used for industrial applications, whereas itsmicrobial contamination has been a major issue in various industries, including the pharma, beverages and food industries (Kulakov *et al*., 2002). Achievement of highly purified water is dependent on the industrial purification process (Proctor *et al*., 2015). The industrial process of water purification involves two major stages; pretreatment and polishing; which is composed of a variety of steps such as filtration, UV light treatment, ozonization and heat treatment to eliminate the presence of bacteria (Rajiv *et al*., 2012).

Filtration, the purification method most widely used in industry, is a process in which the solid particles present in the suspension are parted from the liquid or the gas utilizing a porous medium which retains solids but allows the passage of liquids (Lija, 2011; Prajapati, 2010). Based on the composition of particles and sieve size, it is a physical removal technique for organisms and other particulate matter from drinking water (Stanfield *et al*., 2003). Water purification systems contain a filtration stage where some small particles, suspended solids and with some filters bacteria and viruses are trapped (Khutia *et al*., 2010). The different filtering procedures have their efficient removal ranges based on filter media pore sizes (LeChevallier & Keung, 2004; Stanfield *et al*., 2003). Granular filtration, a widely used filtration method is usually combined with coagulation, flocculation and sedimentation during water treatment (Rapala, *et al*., 2002). The filter media normally consist of fine grains of sand or some other similar material. It has been shown that slow sand filters are often used in industry to remove bacteriophages and microcystin, a cyanobacterium toxin (Rapala *et al*., 2002).

Water purification processes in industries make use of modern filtration units that employs a multistep process to achieve ultrapure water, the efficient removal of fine solids and soluble organic matter, low energy consumption and low maintenance requirements make water filters become widely used in industries (Vignola *et al*., 2018). Water filters harbour enormous amount of bacteria, the presence of these bacteria could either be beneficial such as removal of contaminants or detrimental such as being potentially pathogenic or releasing Dissolved Organic Carbon (DOC) (Richter *et al*., 2008; Pinto *et al*., 2012). Previous studies revealbacteria communities are post-filtration even though water filters have a major impact on the community composition (Pinto *et al*., 2012). However, the extent of the impact it has on water quality is little known. This research, therefore,focused on the bacteriological evaluation of filtration units used in the industry.

Materials and Methods

Sample location

Swab bed samples from the filter unit were collected from the following industries in Ijebu-ode: Nigerian Breweries, SB1 Water and Deluxe Water.

Sample collection

A total of 12 samples from water filtration units of the three selected industries were swabbed. The procedure was repeated four times giving a total of 12 swabbed samples. Swab sticks were used to collect samples from the surface of the filter unit, labelled and transported immediately to the laboratory for microbial analysis.For sample identification, sample codes were assigned to the designated sampling areas. For Nigerian breweries, the sample codes were BRW, BFW, and BSS, which stood for raw water, filtered water, and bed swabs, respectively. While for SB1, the sample codes were SRW, SFW and SS. For Deluxe, DRW, DFW and DSS were also assigned.

Laboratory examination and procedure

Physicochemical analysis: The physicochemical parameters would be evaluated. Temperature, pH, odor, turbidity, and colour are among the parameters analyzed.

Coliform count (TCC):Using 100 microliters of tenfold dilution of the water samples, complete coliform count determination was carried out and then transferred using the spread plate technique to MacConkey agar. The plate was then incubated for 24 h at 37ºC. After incubation, plates with 30 to 300 settlements were counted, then the average colonies were multiplied with a dilution factor for the total coliform count in a specific dilution system. The results were expressed in colonies forming unit per millilitre of water (CFU/ml).

Determination of Total viable count:Using the pour plate procedure, the nutrient agar was used culturing 1 ml of the dilution factor, then the plates were incubated and inverted for 24 h at 37°C. The culture plates with 30-300 colony-forming units were counted and registered in colonies forming unit per millilitre(cfu/ml) after incubation.

Bacteriological analysis: Using the spread plate method, 0.1 ml of 10-2 and 10-5 dilution from each sample was cultured and then incubated for 24 h at 37°C. Separate colonies were observed after incubation, and then subcultured and further incubated for 24 h to classify and characterize the resulting pure isolates using cultural and biochemical characteristics. characteristics.

Results and Discussion

The physical and chemical parameters of the sample of water were observed and are shown below in Table 1. The pH of the water samples ranged from 6.2 to 8.1, with the lowest pH for sample BRW3 and the highest pH for sample BRW2. The water sample temperature ranged from 20.7 to 27.7°C. Sample BRW2 collected before filtration had the highest temperature while sample DFW2 collected after filtration had the lowest temperature. All the water sample were clear, odourless and colourless (Table 2).

Table 1: Physiochemical and chemical parameters of raw and filtered water sample

Sample Code	P_H	Temp. (°C)	Turbidity	Odour	Colour
BRW1	6.6	26.2	Not Turbid	Odourless	Colourless
BRW2	8.1	27.7	Not Turbid	Odourless	Colourless
BRW3	6.2	25.5	Not Turbid	Odourless	Colourless
BRW4	7.4	25.4	Not Turbid	Odourless	Colourless
BFW1	6.6	22.0	Not Turbid	Odourless	Colourless
BFW2	7.2	21.7	Not Turbid	Odourless	Colourless
BFW3	6.3	23.4	Not Turbid	Odourless	Colourless
BFW4	7.3	22.7	Not Turbid	Odourless	Colourless
SRW1	6.4	26.3	Not Turbid	Odourless	Colourless
SRW2	8.1	25.7	Not Turbid	Odourless	Colourless
SRW3	7.6	26.8	Not Turbid	Odourless	Colourless
SRW4	6.6	27.1	Not Turbid	Odourless	Colourless
SFW1	6.4	22.2	Not Turbid	Odourless	Colourless
SFW2	7.3	21.5	Not Turbid	Odourless	Colourless
SFW3	7.6	23.2	Not Turbid	Odourless	Colourless
SFW4	7.8	21.7	Not Turbid	Odourless	Colourless
DRW1	7.0	26.3	Not Turbid	Odourless	Colourless
DRW2	7.8	27.0	Not Turbid	Odourless	Colourless
DRW3	7.6	26.3	Not Turbid	Odourless	Colourless
DRW4	6.8	25.0	Not Turbid	Odourless	Colourless
DFW1	6.6	22.8	Not Turbid	Odourless	Colourless
DFW2	7.3	20.7	Not Turbid	Odourless	Colourless
DFW3	6.9	22.4	Not Turbid	Odourless	Colourless
DFW4	7.8	23.1	Not Turbid	Odourless	Colourless

The gross microbial count of the water sample ranged from 48 to 208 cfu/ml. In sample SRW4, the highest number was observed, followed by sample BRW4, while in sample DRW4, the lowest number was observed. It was found that after treatment, there was no growth in all the samples. The overall microbial count ranged from 178 to 298 cfu/ml from swab samples. In sample SS1, the highest count was observed, followed by sample DSS3, while the lowest count was observed in sample SS2.

Table 2: Total microbial load count of isolates from water samples

Raw water samples		Filtered water samples		Swab samples	
Sample code	**Microbial Count (Cfu/ml)**	**Sample code**	**Microbial Count (Cfu/ml)**	**Sample code**	**Microbial Count (Cfu/ml)**
BRW2	113	BFW1	No Growth	BSS1	248
BRW3	80	BFW2	No Growth	BSS2	186
BRW4	200	BFW3	No Growth	BSS3	180
SRW2	108	BFW4	No Growth	BSS4	190
SRW3	187	SRW1	No Growth	SS1	298
SRW4	208	SFW1	No Growth	SS2	178
DRW2	72	SFW2	No Growth	SS3	287
DRW3	80	SFW3	No Growth	SS4	278
DRW4	48	SFW4	No Growth	DSS1	212
		DRW1	No Growth	DSS2	272
		DFW1	No Growth	DSS3	280
		DFW2	No Growth	DS4	248
		DFW3	No Growth		
		DFW4	No Growth		

Following identification and characterization using a standard microbiological procedure with the aid of cultural, morphological and biochemical characteristics. A total of twenty-two bacteria belonging to six genera were isolated from the samples collected (Ten isolates from water samples and twelve from swab samples). The isolated organisms include *Klebsiella pneumonae, Staphylococcus aureus, Pseudomonas aeruginosa, Enterobacter* spp., *Escherichia coli, Chomobacterium violaceum* and *Staphylococcus epidermidis* (Table 3).

Table 3: Percentage of occurrence of isolates from raw water and bed filter samples

Organism	Raw Water		Bed filter	
	Freq.	%	Frequency	%
Klebsiellia pneumonae	3	30	3	25
Staphylococcus aureus	3	30	4	33
Enterobacter spp	1	10	2	17
Pseudomonas aeruginosa	2	20	0	0
Eschericha coli	0	0	1	8
Staphylococcus Epidermidis	0	0	2	17
Chomobacterium violaceum	1	10	0	0
Total	10		12	

Filtration is one of the most effective separation methods used for the removal of microbial pollutants in industries. It has been in existence for over a century to avoid outbreaks of disease from water or drinks produced in industries. The pH of the water samples observed in this study ranged from 6.2 to 8.1 and this corresponds to the drinking water pH standard of the WHO, which is between 6.5 and 8.5 (WHO, 2007). Water's pH is very significant, the pH of most natural waters ranges from 6.5 - 8.5 while the CO2/bicarbonate/carbonate balance results in deviations from the neutral 7.0, variations in water pH levels lead to an increase or decrease in water toxicity (Okonko *et al*., 2008). The water sample temperatures varied between 20.7 and 27.7°C. Although the temperature can affect filtration, the temperature range obtained in this study falls under the European Community's limit (2018) of 25^0C (maximum standard for drinking water temperature). All samples of water are hygienic and pleasant in terms of drinking, as well as being Colourless and Odourless.

The overall microbial count from the raw water sample ranged from 48 to 208 cfu/ml, but no growth was observed in the filtered water sample. The observed microbial load is substantially higher compared to the WHO (2000) standard, and the findings of this research are also consistent with the study carried out by Peterson *et al.* (2012).

Six distinct bacterial isolates consisting of *Klebsiella pneumonae, Staphylococcus aureus, Pseudomonas aeruginosa, Chromatium okenii*, *Enterobacter* spp. and *Staphylococcus epidermis* were obtained from a total of twenty-one bacterial samples from raw water, filtered water and swab cultures found in this study, these findings are in line with Kalpana *et al.* (2011) and Popoola *et al.* (2007) where isolates of bacteria were observed in polluted drinking and recreational water. . The presence of some of these organisms in water samples has also been reported by Okonko *et al.* (2008). Isolated species of bacteria were described as similar in water and marine environments (Okonko *et al*., 2008). The results of Dall'Agnol *et al.* (2008) who found Chomobacterium violaceum in the aquatic ecosystem are also in line with this research. It is not surprising that Chomobacterium violaceum is found primarily in icing water.

The study carried out by Hungria *et al.* (2005) also confirmed the existence of Chomobacterium violaceum in Amazonas isolates (Hungria *et al*., 2005).

The bed filters used for water filtration were analyzed for the presence of isolated bacteria. Isolates of bacteria like *Escherichia coli*, Staphylococcus sp and *Klebsiella* sp. were prominent. The findings observed in this research were consistent with a Zanacic *et al.* (2017) study in which few enteric coliforms were detected in filters used for water treatment. However, the isolates found in this research from the bed filters disagree with a study conducted by Ranjan *et al.* (2018), who identified *Pseudomonas* sp. as the dominant species of bacteria in water filters, this disagreement might be due to the difference in filter composition and environmental conditions.

Conclusion

Even though raw water gotten from the industries has undergone some treatments, it still needs to be filtered for it to be safe for drinking and manufacturing purpose because data obtained from this study results clearly show that an appreciable degree of treatment had taken place when the raw water with pathogenic organism undergo filtration. It could be dangerous if the water used in industries are not purified, hence the need for water filtration to render it safe for drinking and manufacturing purpose. From the findings of this study, it was recommended that the sources of water in industries should be carefully examined to continue to have confidence in the water used for production purpose. Also, there should be a routine check on the water that is used for domestic purpose and production because it was found in this study that swab samples taken from filtration unit were contaminated, though the water was hygienic, this may pose threat to the public. Therefore, there is a need for frequent sterilization for the filter used in industries.

Conflict of Interest

The authors declare that there is no conflict of interest related to this work.

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