

## Microbial and Physicochemical Quality of Harvested Rain Water in Eku and Abraka Metropolis

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*Date Received:* 08-12-2021

*Date Accepted:* 22-02-2022

**DOI:** <https://doi.org/10.48198/NJPAS/21.B19>

### ABSTRACT

The study design was aimed at assessing the microbial as well as physicochemical qualities of harvested rain-water in Abraka and Eku metropolis. Thirty (30) samples, five (5) each were randomly collected from different environs within Abraka and Eku metropolis between the months of February and March, 2020. Standard microbiological procedures and biochemical techniques were conducted for the isolation, characterization and identification of bacterial isolates. Fungal isolations were done by microscopic and macroscopic examinations. The result findings of the total bacterial counts was observed to range from  $3.7 \pm 0.34$  to  $5.7 \pm 0.32 \times 10^3$  CFU/ml for sampled water obtained from Okomuku and Okurekpo respectively. Also, the counts of coliform and fungi ranged from  $1.0 \pm 0.42$  to  $4.4 \pm 0.26 \times 10^3$  CFU/ml;  $2.6 \pm 0.18$  to  $4.7 \pm 0.26 \times 10^3$  CFU/ml respectively. Ten (10) species of bacteria were identified which includes: *Escherichia coli*, *Salmonella* sp., *Klebsiella* sp., *Shigella* sp., *Staphylococcus* sp., *Bacillus* sp., *Micrococcus* sp., *Proteus* sp., *Pseudomonas* sp. and *Enterococcus* sp. While the identified fungi include: *Rhizopus* sp., *Aspergillus fumigatus*, *Aspergillus niger*, and *Penicillium* sp. The result of percentage prevalence of bacterial species showed that *Escherichia coli* (22.2%) had the highest occurrence, while *Proteus* sp. (7.9%) and *Enterococcus* sp. (7.9%) were the least dominant isolates. Whereas, in fungal isolation, *Aspergillus fumigatus* (25%) was the most dominant compared to *Rhizopus* sp. (21.4%) and *Penicillium* sp. (17.8%) which followed in order of dominance. Virtually all antibiotics were observed to be susceptible to the Gram negative and positive bacterial isolates especially Ciprofloxacin (83%) and Chloramphenicol (100%). Results of the physicochemical properties and heavy metal ion compositions fell within the allowable limit set-up by the World Health Organization. However, the high contamination by microbes as revealed in the study could cause water-borne diseases and infections to consumers if not properly treated.

**Keywords:** Rainwater Harvesting, Potability, Physicochemical, Parameters

### Introduction

Globally, particularly in Africa, safe water is a necessary reserve, though in short supply. As a result of shortage of safe and consumable water supplies, man has always been on lookout for

potable water resources. In response to increasing unavailability of safe and consumable water by man, rain-water harvesting has proven to be an alternative means of surface-water source. Reports

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by scientist have argued that rainwater remains the best consumable water source (Amin and Alazba, 2019).

Retamal and Turner (2010) reported that rainwater harvesting enhances self-dependency and promotes water and energy conservation leading to low demand of water supply. However, several publications by scientist have opposed the quality of harvested rain-water as a better choice of water for man's consumption (Meera and Ahammed, 2006). A report by Yufen *et al.* (2008) revealed that rainwater can retain soil particles, heavy metals, pathogens and nutrients which contaminates the water thereby rendering it unsafe for drinking and domestic usage.

Rainwater harvesting is sourced mostly in areas with high rainfall and low borehole water supply systems. At the period of rainfall, water can be harvested either directly or through catchment systems for storage and direct usage. Rainwater serves as a potable means of water supply for residents in the rural settings due to poor water supplies ranging from streams and rivers. Water quality is of utmost significance in accessing the portability of water. Several factors have been highlighted to affect the quality of rain-water harvesting such as the roofing material and catchment system types, industrial and environmental pollutions, automobiles, and anthropogenic activities, organic matter composition as well inorganic matter which may find their way to the water tank (Amin and Han, 2009).

Three main designs were adopted for maximizing the quality of rain-water such as treatment, storage and catchment materials. The correlation between storage tanks, microbial and physicochemical properties of harvested rain-water has also been reported. It has been observed that roof surfaces can be an easy channel of contamination for rainwater. Storage-tanks also plays a significant role in determining the harvested rain water quality, usually when water is stored for a longer

period of time before consumption (Cuoco *et al.*, 2013).

Hart and White (2006) reported that in metal tanks, leaching of metals influenced the concentration of copper, zinc and lead, but no impact occurred in the case of concrete or plastic tanks at same concentrations. Leaching of organic compounds has been a concern with plastic tanks.

The negative impact of microbes on consumers arising from poor quality of harvested rainwater at household level has been documented. Microbes can be distributed to the environment by animal and bird vectors which include: *Cryptosporidium* spp., *Giardia* spp., *Salmonella* spp. and *Campylobacter* spp. (Gerba and Smith, 2015). These microbes are potential causes of several diseases including gastroenteritis and diarrhea. Tank materials also show great impact on the degree of contamination. It is very important that public health education be strengthened on the aspect of rainwater harvesting so as to minimize or prevent the risk of contracting waterborne diseases and infections by consumers (Gerba and Smith, 2015).

Usually for most communities in Ethiopia East Local Government Area, harvested rain water serves as a main source of water for all kinds of domestic usage and man's consumption after river Ethiopia. This was my observation during the preliminary survey. The indigenes of these communities might be at risk of suffering from water borne diseases and infections due to lack of potable water supply systems. Thus, it became necessary to evaluate the microbial and physicochemical qualities of harvested rain water supplies across Abraka and Eku metropolis for public health interest.

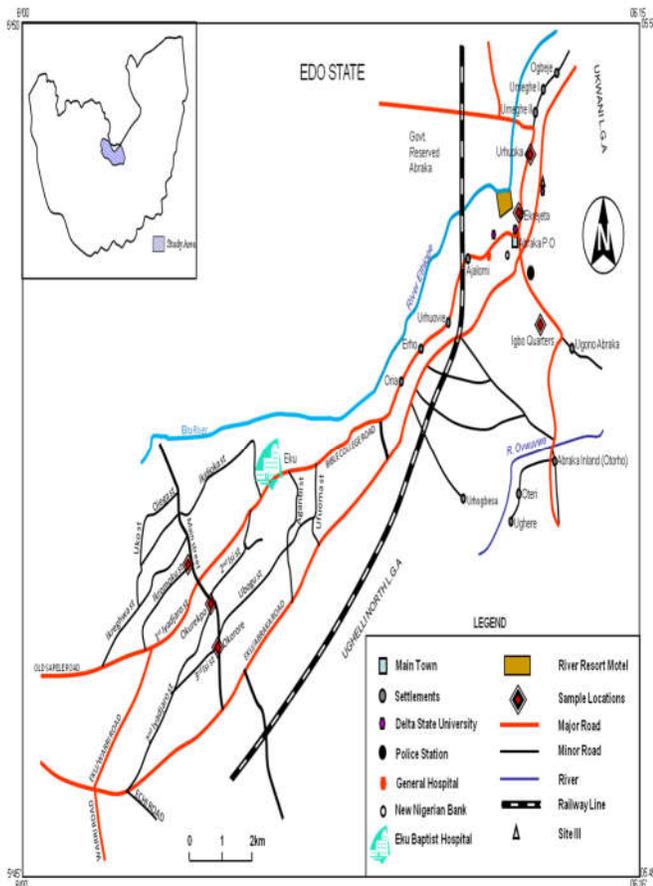
## Materials and Methods

### Study Area

This research work was conducted in Abraka and Eku metropolis within the months of February and March, 2020. They are two major towns in Ethiopia East Local Government Area, Delta State of

Nigeria and are located between latitude 5°54'N, longitude 5°40'E (Ito *et al.*, 2014). Farming and trading are the main occupation in these localities with high numbers of primary, secondary, and one tertiary institution. Six (6) major communities (Ekrejeta, Urhuoka, Igbo Quarters, Okorore, Ikomuku, Okurekpo) were picked as sampling sites by reason of the increased number of inhabitants in those area.

Page | 4241



**Figure 1:** Map of Abraka and Eku metropolises showing the sampling sites (Ito *et al.*, 2014).

### Collection of Samples

Thirty (30) harvested rain-water samples five (5) each were picked randomly from different sites in Abraka and Eku metropolises. After 10 minutes of rainfall samples were collected to ensure the cleansing of roofing sheet. Harvested rain water samples were taken to microbiology and chemistry

laboratory respectively for microbial and physiochemical analysis.

### Bacteriology of Harvested rainwater samples

Membrane filtration technique was conducted for enumeration of total viable and coliform counts (Habash and Johns, 2009). A pore sized 0.45  $\mu\text{m}$  of a sterile membrane filter was employed for the filtration of 100 ml of samples. The paper filter was mounted on an already prepared or solidified Membrane Lactose Glucuronide agar plate in inverted form. Thereafter, plates were incubated at 37 °C for 20 hrs and at 44.5°C for 24 hrs respectively for the counts of total coliform and thermo tolerant faecal coliforms. Greenish with yellow clusters were recorded as total coliform whereas plates observed as green and yellow clusters were recorded as thermo-tolerant faecal coliforms using a colony counter reported as Colony Forming Units (CFU) per 100ml. Gram staining reactions, morphological test, and relevant biochemical techniques were employed for identification.

### Microscopic and Macroscopic identification of fungal species

Size, shape and type of budding of vegetative cells were microscopically examined via a pure culture of previously incubated isolates of 24-48 hours. The cultural characteristics were determined to ascertain the growth, appearance and pigments.

### Antibiotic Susceptibility Testing

Each bacterium was subjected to antibiotic susceptibility testing by the use of Kirby Bauer's disc-diffusion technique (Bauer *et al.*, 1966). Standard inoculums, reduced to 0.5McFarland turbidity, was swabbed by inoculation on a Mueller Hinton agar plate thereafter they were left in soaked form for about 2 to 5 mins. After 5 minutes, the discs were mounted on the media surface and pressed gently using sterile forceps. Thereafter, the plates with the discs were incubated at 37 °C for 24 hr. After the 24 hours, the discs were observed for

sensitivity or resistance. Inhibition zones were noted by measurement using caliper/ruler according to standards initiated by the clinical and laboratory standard institute (CLSI, 2016).

### Physicochemical compositions and heavy metal contents

All analysis was conducted at NIFOR- Nigerian Institute for palm Oil Research Benin City, Edo State, Nigeria. The research adopted World Health Organization procedures. The turbidity, electrical conductivity, dissolved solids, pH, total hardness, salinity, total dissolved solids, were examined at the collection site with the use of HANNA combo (H198130) instrument via a connection between electrodes submerged onto a sterile beaker having the sample as noted from the manufacturer's instructions. Other parameters includes: copper, iron, cadmium, zinc, calcium, sodium, potassium, and cobalt were examined at chemistry laboratory department of NIFOR. Heavy metal composition was examined via a digestion process with 55% concentrated nitric acid using an Agilent (240) FS flame atomic-absorption spectrophotometer (USA). Calibration of equipments was used as standard solution. Laboratory standardized reagents; chemicals were employed for the survey (APHA, 1998).

### Statistical Analysis

SPSS version 21.0 and Microsoft excel 2013 was used to analyze the data. Descriptive analysis ANOVA was used. The P-values <0.05 were noted statistically significant (Ogbeibu 2005).

### Results

Table 1. Represents the mean total count of bacterial isolates. The counts ranged from  $3.7 \pm 0.34$  to  $5.7 \pm 0.32 \times 10^3$  CFU/mL Ikomuku and Okurekpo respectively. Table 2. Reveals the total coliform counts which falls within the range of  $1.0 \pm 0.42$  to  $4.4 \pm 0.51 \times 10^3$  CFU/mL for Ikomoku and the Igbo quarters respectively. The reason for high counts of coliform in Abraka as compared to other region

might be as a result unhygienic condition of the environ arising from several activities engaged by students attending the State university such as regular generator use in their hostels, un-kept refuse dumpsites which could pollute the environment with several airborne microbes and harmful gases. Table 3 is represented as the total fungal counts which fell with the range of  $2.6 \pm 0.18$  to  $4.7 \pm 0.26 \times 10^3$  CFU/mL for Okorore and Okurekpo respectively. Gram reaction, morphological and biochemical test evaluation of the bacterial isolates are in Table 4. The bacterial species were *Bacillus* sp., *Escherichia coli*, *Klebsiella* sp., *Shigella* sp., *Staphylococcus* sp., *Enterococcus* sp., *Pseudomonas* sp., *Micrococcus* sp., *Proteus* sp. and *Salmonella* sp. *E. coli* (22.2%) was most dominant bacteria whereas *proteus* sp. (7.9%) and *Enterococcus* sp. (7.9%) appeared as less prevalent as shown in Table 5. Fungal species were detected macroscopically and microscopically as shown in Table 6. The fungi species isolated were *Rhizopus* sp., *Aspergillus fumigatus*, *Aspergillus niger* and *Penicillium* sp. In Table 7. The prevalence rate of fungi showed that *Aspergillus fumigatus* (25%) was the most dominant compared to *Rhizopus* sp. (21.4%) and *Penicillium* sp. (17.8%) which followed in order of dominance. The antibiotics susceptibility test of the Gram negative bacterial isolates are presented in Table 8 and 9. The Gram negative drugs showed susceptibility to the tested isolates except cefixime (0%), rifampicin (0%) and ofloxacin (0%). Table 10. Reveals the susceptibility profile of the Gram positive isolates. Most of the drugs were susceptible to the tested isolates except Erythromycin (50%), gentamycin (50%) and sparfloxacin (50%) which showed less susceptibility as revealed in Table 11. The physicochemical results and heavy metal compositions of the water samples are shown in Tables 12 and 13 respectively. The results fell within the WHO acceptable range.

**Table 1:** Total bacterial count of harvested rain water samples (x10<sup>3</sup>)

Sample location	Mean count
Abk 1	4.9±0.32
Abk 2	5.6±0.17
Abk 3	4.3±0.55
Ekü 1	3.8±0.22
Ekü 2	3.7±0.34
Ekü 3	5.7±0.32
P-value	P<0.05

**Keys:** Abk 1 = Ekrejeta, Abk 2 = Urhuoka, Abk 3 = Igbo Quarters, Ekü 1 = Okorore, Ekü 2 = Ikomoku, Ekü 3 = Okurekpo

**Table 2:** Total Coliform count of the harvested rain water (x10<sup>3</sup>)

Sample location	Mean count
Abk 1	3.8 ± 0.16
Abk 2	2.9 ± 0.32
Abk 3	4.4 ± 0.51
Ekü 1	2.1 ± 0.12
Ekü 2	1.0 ± 0.42
Ekü 3	4.0 ± 0.26
P – Value	P < 0.05

**Keys:** Abk 1 = Ekrejeta, Abk 2 = Urhuoka, Abk 3 = Igbo quarters, Ekü 1 = Okorore, Ekü 2 = Ikomoku, Ekü 3 = Okurekpo

**Table 3:** Total fungal count of harvested rain water (x10<sup>3</sup>)

Sample location	Mean count
Abk 1	4.0 ± 0.11
Abk 2	4.3 ± 0.17
Abk 3	3.7 ± 0.42
Ekü 1	2.6 ± 0.18
Ekü 2	3.9 ± 0.55
Ekü 3	4.7 ± 0.26
P – value	P < 0.05

**Keys:** Abk 1 = Ekrejeta, Abk 2 = Urhuoka, Abk 3 = Igbo quarters, Ekü 1 = Okorore, Ekü 2 = Ikomoku, Ekü 3 = Okurekpo.

**Table 4:** Bacterial specie Identification

Shape	Gram reaction	Catalase test	Oxidase test	Citrate test	Indole test	H <sub>2</sub> S	Gas	Lactose	Sucrose	Acid	Glucose	Motility test	Tentative organisms
Rod	-	+	-	+	+	-	+	-	+	+	+	+	<i>Escherichia</i> sp.
Rod	+	+	-	-	+	+	-	-	-	+	+	+	<i>Bacillus</i> sp
Cocci	+	+	-	-	-	-	+	-	-	+	+	+	<i>S. aureus</i>
Rod	-	+	+	+	-	-	+	-	-	-	+	+	<i>Klebsiella</i> sp.
Rod	-	+	-	+	-	+	+	+	+	+	+	+	<i>Proteus</i> sp.
Rod	-	+	-	-	-	+	+	-	-	+	+	+	<i>Salmonella</i> sp.
Rod	-	+	-	-	-	-	+	-	-	+	+	+	<i>Shigella</i> sp.
Rod	-	+	-	+	-	-	+	-	-	-	-	+	<i>Pseudomonas</i> sp.
Rod	-	+	-	+	-	-	+	+	+	+	+	+	<i>Enterococcus</i> sp.
Cocci	+	+	+	-	-	-	-	-	-	-	-	-	<i>Micrococcus</i> sp.

**Table 5:** Prevalence of the tentative Bacterial Isolates

Microbes Isolated	Prevalence (%)
<i>Pseudomonas</i> sp	12.6
<i>Salmonella</i> sp.	12.6
<i>Staphylococcus aureus</i>	11.1
<i>Escherichia coli</i>	22.2
<i>Klebsiella</i> sp.	12.6
<i>Enterococcus</i> sp.	7.9
<i>Proteus</i> sp.	7.9
<i>Bacillus</i> sp	11.1

**Table 6:** Fungal specie identification

Cultural morphology	Microscopic characteristics	Fungal species
Colony growth appears brownish black coloration while some are slight yellow/orange	Round conidiophores with brownish vesicles globose with appearance of a stenigmata and a branched hyphae	<i>Aspergillus niger</i>
Colony widespread over the plate. Light brownish colour at the center and whitish edges	Conidiophore colored in shades of green and short. Conidia in chain on sterigmata, vesicle brownish coloured with hyphae septate	<i>Aspergillus fumigates</i>
Surface of colony bluish-black spreading with yellow underneath	Hyphae septate and branched conidiophores septate with branchlets. Conidia appears in chains.	<i>Penicillium</i> sp
White colony underneath	Sporangia appears brownish-black, globose to subglobose, sporangiosphere are irregular in shape, slightly rough walled stolons opposite the branched rhizoid.	<i>Rhizopus stolonifer</i>

Page | 4244

**Table 7:** Prevalence of Fungi species

Fungal isolates	Prevalence (%)
<i>Aspergillus niger</i>	35.7
<i>Aspergillus fumigates</i>	25
<i>Rhizopus</i> spp.	21.4
<i>Penicillium</i> spp.	17.8

**Table 9:** Percentage antibiotic susceptibility test of Gram negative bacteria

AMP	CFX	CA2	CIP	RIF	COT	OFX	AZM	AMX	PEF
67%	0%	83%	83%	0%	83%	0%	83%	67%	83%

**Keys:** AMP = Ampicilin(30Ug), Cefixime(5Ug), CAZ = Ceftazidilin (30Ug), CUP = Coprofloxacin (5Ug), RIF = Rifampicin (5Ug), COT = colistin (10Ug), OFX =Ofloxacin (5Ug), AZM = Azithromycin (15Ug), AMX = Amoxicilin (25Ug), PEF = Pefloxacin (5Ug), R = Resistant, S = Sensitive.

**Table 8:** Antibiotic Susceptibility Test of Gram Negative bacteria

Organisms	Sensitivity Profile (mm)									
	AMP	CFX	CAZ	CIP	RIF	COT	OFX	AZM	AMX	PEF
<i>Escherichia coli</i>	S(16)	R(12)	R(14)	S(16)	R(12)	S(16)	R(12)	S(18)	S(16)	S(16)
<i>Salmonella</i> sp.	R(14)	R(10)	S(18)	R(14)	R(12)	S(18)	R(10)	S(16)	R(14)	R(14)
<i>Klebsiella</i> sp.	S(18)	R(12)	S(16)	S(20)	R(10)	R(14)	R(8)	S(16)	S(16)	S(18)
<i>Pseudomonas</i> sp.	S(18)	R(10)	S(18)	S(20)	R(10)	S(18)	R(10)	S(20)	S(18)	S(20)
<i>Proteus</i> sp.	R(14)	R(8)	S(20)	S(18)	R(8)	S(20)	R(12)	S(18)	R(14)	S(18)
<i>Enterococcus</i> sp.	S(20)	R(12)	S(16)	S(16)	R(10)	S(18)	R(8)	R(14)	S(20)	S(16)

**Source: (CLSI, 2016)**

**Keys:** AMP = Ampicilin (BOUS), Cefixime(5Ug), CAZ = Ceftazidilin (30Ug), CUP = Coprofloxacin (5Ug), RIF = Rifampicin (5Ug), COT = colistin (10Ug), OFX =Ofloxacin (5Ug), AZM = Azithromycin (15Ug), AMX = Amoxicilin (25Ug), PEF = Pefloxacin (5Ug), R = Resistant, S = Sensitive.

**Table 10: Antibiotic Susceptibility Test of Gram Positive bacteria**

Organisms	Sensitivity Profile (mm)									
	CPX	CH	ERY	LVX	OXA	RIF	TET	VAN	GEN	SPX
<i>S. aureus</i>	S(16)	S(18)	S(16)	S(16)	S(14)	S(18)	S(18)	S(20)	S(14)	S(18)
<i>Bacillus sp.</i>	S(16)	S(16)	S(14)	S(18)	S(18)	S(16)	S(16)	S(18)	S(16)	R(8)

**Source: (CLSI, 2016)**

**Keys:** CPX = ciprofloxacin (5Ug), CH = chloramphenicol (30Ug), LVX = Levofloxacin (5Ug), ERX =Erythromycin (15Ug), OXA = Oxacilin (1Ug), RIF = Rofampin (5Ug), TET = Tetracycline (30Ug), VAN = Vacomycin (5Ug), GFN = Gentamycin = (10Ug), SPX = Sparfloxacin (5Ug), R = Resistance, S = sensitive.

**Table 11: Percentage antibiotic susceptibility test of Gram negative bacteria**

CPX	CH	ERX	LVX	OXA	RIF	TET	VAN	GEN	SPX
100%	100%	50%	100%	100%	100%	100%	100%	50%	50%

**Keys:** CPX = ciprofloxacin (5Ug), CH = chloramphenicol (30Ug), LVX = Levofloxacin (5Ug), ERX =Erythromycin (15Ug), OXA = Oxacilin (1Ug), RIF = Rofampin (5Ug), TET = Tetracycline (30Ug), VAN = Vacomycin (5Ug), GFN = Gentamycin = (10Ug), SPX = Sparfloxacin (5Ug), R = Resistance, S = sensitive.

**Table 12: Physicochemical compositions of the harvested rain water**

Location/sou urce	Temperature	Turbidity	pH	TDS	Total hardness	Electrical conductivity
Abraka 1	26.7 ± 0.55	3.1±0.09	7.0 ±0.13	33.5± 0.33	2.8 ± 0.23	11.5 ± 0.41
Abraka 2	26. ± 0.13	3.3±0.04	7.3 ±0.36	33.9±0.11	4.3±0.11	11.0±0.28
Abraka 3	26.3±0.20	3.0±0.22	7.2±0.28	24.7±0.22	7.4±0.35	14.7±0.23
Ekú 1	25.8±0.16	3.4±0.43	6.8±0.17	30.5±0.20	3.4±0.37	15.0±0.12
Ekú 2	27.2±0.34	2.8±0.42	7.1±0.13	29.2±0.8	4.2±0.25	13.6±0.23
Ekú 3	26.4±0.52	3.6±0.75	6.0±0.40	35.0±0.16	3.8±0.44	15.1±0.50
P – value	0.8345	0.0882	0.1024	0.1026	0.0345	0.0000
WHO Limit	25 – 27	0.1 – 4.0	6.5 – 9.0	500	120 – 180	1000

**Table 13: Concentration of metal ions (mg/l) in harvested rain water by sample sites (M±SE)**

Location/sou rce	Cu	Fe	CD	Zn	Ca	Cb	Na	K
Abk1	0.8±0.16	5.0±0.42	0.5±0.42	0.3±0.30	3.7±0.22	0.2±0.30	0.1±0.33	2.2±0.52
Abraka 2	1.2±0.35	5.8±0.56	0.3±0.51	0.3±0.12	2.3±0.45	0.2±0.26	0.2±0.02	2.6±0.12
Abraka 3	1.6±0.37	6.1±0.17	0.3±0.31	0.8±0.37	22±37	0.2±0.44	0.9±0.09	3.2±0.06
Ekú 1	0.3±0.01	5.9±0.45	0.8±0.14	0.2±0.17	31±0.28	0.1±0.10	0.3±0.20	2.4±0.24
Ekú 2	0.6±0.27	4.8±0.41	1.0±0.56	0.3±0.13	29±0.33	0.2±0.12	0.2±0.18	3.5±0.39
Ekú 3	1.7±0.23	6.0±0.27	0.4±0.34	1.2±0.09	35±0.41	0.2±0.30	0.1±0.37	2.6±0.13
P – value	0.0521	0.0000	0.0145	0.2657	0.1402	0.2314	0.2976	0.5341
WHO limit	0.5 – 1.5	0.1 – 1.0	0.02-0.05	10 – 15	75 – 200		200	

## Discussion

The result showed that the bacterial count (TBC) ranged from  $3.7 \pm 0.34$  to  $5.7 \pm 0.32 \times 10^3$  CFU/ml for samples obtained from Ikomuku and Okurekpo communities for Eku environs. There were significant differences observed across sampled sites ( $P < 0.05$ ). These counts are however, higher than the recommended standard of  $1.2 \times 10^2$  CFU/ml by the WHO (2011). This report conforms to the research by Unimke *et al.* (2018) for rain water quality used within communities in Calabar, Nigeria. In some cases, external factors to the tanks could have led to the presence of high bacterial counts in the study. *E. coli* for instance, has been reported to survive in an environment with certain degrees of nutrients, temperature and pH (Van Elsas *et al.*, 2011). Also, the presence of bacteria could be connected with rainwater droplets arising from rainfall events through pipe channels, or water exposure to the atmosphere could facilitate the presence of these bacteria into the harvested water. Similar report was made by Chubuka *et al.* (2018) on Microbiological Values of Rainwater Harvested in Adelaide.

Results of the total coliform counts showed that water samples obtained from Ikomuku ( $1.0 \pm 0.42 \times 10^3$  CFU/ml) had the least count, followed by samples obtained from Okorore community ( $2.1 \pm 0.12 \times 10^3$  CFU/ml) while the highest count of coliform bacteria was observed in water samples obtained from Igbo quarters ( $4.4 \pm 5.1 \times 10^3$  CFU/ml) in Abraka environs. The counts were exceeded the WHO standard of  $1.2 \times 10^2$  CFU/ml. The reason for high coliform counts in Abraka samples as compared to other region might be due to unhygienic environmental conditions arising from several activities engaged by students attending the State University such as regular generator use in their hostels, un-kept refuse dumpsites which could pollute the environment with several airborne microbes and harmful gases. The findings corroborates with the

report of Gambo *et al.* (2015) on the physicochemical and bacteriological analysis of well water at crescent road poly quarters Kaduna.

Fecal matters are likely sources of coliforms arising from dead birds, rodents and insects in water body (Magnus, 2011).

The fungal counts were within the range of  $2.6 \pm 0.18$  to  $4.7 \pm 0.26 \times 10^3$  CFU/ml for samples obtained from Okorore and Okurekpo communities respectively. Reported counts were higher than the usual standard limit of  $1.2 \times 10^2$  CFU/ml by WHO (2011). Significant difference ( $P < 0.05$ ) was observed for the counts of fungi across sampling sites. The fungal counts are attributed to poor sanitary conditions noticed in the storage tanks. Some are uncovered and has not been washed over a long period. Also, most of the communities when visited had pit latrines constructed in close location from the water storage system, thus leading to an easy access for flow of fungi in water body Trivedi *et al.* (2010).

The bacterial species were *Proteus* sp., *Escherichia coli*, *Enterococcus* sp., *Salmonella* sp., *Pseudomonas* sp., *Staphylococcus* sp., *Bacillus* sp., *Shigella* sp., *Micrococcus* sp. and *Klebsiella* sp. The isolates are common causes of diseases and infection like typhoid, cholera, and dysentery. Similar isolations were made by Oluyeye *et al.* (2020) on water used for recreational activities in Ado-Ekiti metropolis.

Four (4) species of fungi were identified by microscopic and macroscopic examination and they include: *Rhizopus* sp., *Aspergillus fumigatus*, *Aspergillus niger* and *Penicillium* sp. Similar report was made by Babic *et al.* (2017) on a regulation of drinking water contaminants by fungus. Results of percentage prevalence revealed that *E. coli* (22.2%) occurred more in order of dominance thus suggesting the presence of faecal contaminants in the water systems. Thus, occupants of the studied localities might be susceptible to waterborne diseases especially

diarrhea and gastroenteritis. *Aspergillus niger* (35.7%) was frequently dominant while *Aspergillus fumigatus* (25%) was reported to be the least dominant fungus. Some species of *Aspergillus* are known to harbor several toxic metabolites like *maliformius*, *naphtha pynues*. The susceptibility profile of the sampled waters for Gram-negative bacteria isolates revealed that Ampicilin (67%), Amoxicilin (67%), Ceftazidine (83%), Copoploxacus (83%), Colistin (83%), Azothromycin (83%) and Pefloxatin (83%) were mostly susceptible drugs while cefixime (0%) Rifampicin (0%) and Ofloxalin (0%) were the least sensitive antibiotics in the study. Similar findings were reported by Okoh (2012) who also reported high susceptible drug from his survey. The research findings also reported that the tested drugs for Gram positive bacterial isolates were more susceptible and can be useful for possible treatment of water borne diseases and infections.

The temperature of the sampled waters fell below the allowable standard of the WHO (2011). This could influence the microbial types in the sampled waters. The level of turbidity was satisfactory and within the acceptable limit by WHO (2011). The low recorded values of turbidity were due to sterility of catchment system and storing tanks resulting from frequent rain in that region. This disagrees with finding of Zdeb *et al.* (2020) for rain water quality from roofs and possibility of its economic use.

The pH neutrality of the sampled waters fell within the acceptable standard (6.8-8.5) by WHO (2011). This could be due as a result of the level of dissolved minerals leached into the tanks. The report was similar to the report of Ogbeifun *et al.* (2019).

The values of total dissolved solids in the study also fell within the allowable limit by WHO (2011) which is an indication that the waters do not contain heavy load of decaying organic matter. This also had great impact in the growth rate of coliform bacteria being isolated. The report

is in line with findings of (Iyasele and Idiata, 2011; Ogbeofun *et. al.*, 2019). The values of Total hardness also fell within the allowable limit or standards by WHO (2011). The values of electrical conductivity fell within the range of 11.0 to 0.28 to 15.1 to 0.50. The values fell within the allowable standard (1000us/cm and 50mg/l) recommended by WHO (2011). This influences the ionic compositions of the harvested waters (Ogbeofun *et. al.*, 2019).

All heavy metals compositions examined including: Cupper (cu), Calcium (ca), Zinc (zn), Cobalt (cb) Cadmium (cd), Iron (fc), Sodium (na) and potassium (k) fell within the allowable limits by WHO (2011). The waters is thus, free of harmful and toxic chemicals that might cause serious health challenges to the users. This finding agrees with Odiana and Edosomwan (2019) who recorded low values of certain trace metals in a research conducted in Edo State.

## Conclusions

Findings from the study showed that samples collected from Abraka and Eku environs were heavily contaminated with bacterial and fungal pathogens, as counts were far more than the WHO acceptable standard. Although, the physic-chemical quality of the waters and heavy metal compositions fell within the WHO standard, but the result cannot measure completely the neutrality of the waters for consumption. The result of antibiotic susceptibility test, served as a means in search for safe and efficient antibiotics for treatment of waterborne diseases.

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