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Assessment of microbial properties, and heavy metals contents of surface water and ground water samples In Ureje and Ireje, Ekiti State, Nigeria.

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Abstract

Water is everywhere, · it is the most basic and necessary element of life, as well as the most important and abundant compound in the ecosystem. Standard methods were used to evaluate the physicochemical properties, microbial properties, and heavy metal content of river and well water samples in Ekiti State, South-West Nigeria. Important parameter like pH, electrical conductivity, total dissolved solids, DO, BOD, turbidity, total alkalinity, total hardness, heavy metals and microbial properties are determined. The research work indicated that temperature, odour, pH, alkalinity, TDS, biochemical oxygen demand, DO, chloride, nitrate and turbidity were within the range of WHO permissible limits for drinking water while color, Conductivity, iron and manganese were above the WHO permissible limits. The study also indicated that the microbial contents such as total viable count, yeast/mold and coliform were above the WHO permissible limits for drinking. These results show that the water sources were slightly contaminated and unsafe for human consumption. This water must be treated before it may be consumed or used for domestic application.

Keywords: Microbial properties; Heavy Metals; Ground water; Surface water

1. Introduction

Water is everywhere, · it is the most basic and necessary element of life, as well as the most important and abundant compound in the ecosystem. Water is used by all living things on the earth for growth and survival since it supports life activities and is a necessary prerequisite for life to exist. Baptist (1980). Currently, only the earth has around 70% of its surface covered with water. Water is the most abundant natural resource and the second most significant human need, according to Baptist (1980). Rain, wells, streams, rivers, lakes, and dams are all examples of water sources. Water can be surface or ground water, and is utilized for drinking, irrigation, and power generation Rain, wells, streams, rivers, lakes, and dams are all examples of water sources. Water can be surface or ground water, and is utilized for drinking, irrigation, and power generation (Neha et al., 2013). Humans engaged in various activities such as the processing and use of metal-based materials, mining, and the discharge of industrial effluents containing various forms of contaminants into water bodies (Adeyeye 1994). Human activities, particularly domestic and industrial wastes, are the most common sources of contamination of water sources, according to Samian et al., (2015) and Loukas (2010), while other factors such as atmospheric transport, plant pollens, and material transport with surface waters also contaminate water bodies.

Water quality relates to the physical, chemical and biological characteristics of the water. It is used to assess drinking water safety for humans and also for the health of the ecosystem. It is therefore essential to have good quality water which is free and impurities in order to improve the quality of life and prevent water-borne disease. And also it is important to elucidate the current water quality characteristics Of ureje River and well water (Ado-Ekiti), which will serve for proper monitoring, process control and auditing of the physicochemical properties, minerals and heavy metals contents and microbiological qualities of the river water. Various parts of the world's population are facing severe water

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scarcity, with nearly half of them living in India, China, and developing African nations like Nigeria. The little available water is being polluted by various human activities, and industrial effluents are discharged into different water bodies almost exclusively without adequate treatment, resulting in nutrient reduction, toxic compound accumulation in biomass and sediments, and dissolved oxygen loss. A lot of studies have been undertaken to analyze water quality; however regular checking of water is important due to seasonal variation and to ascertain if the water is good for consumption and commercial uses or requires proper treatment before consumption and commercial uses. The aim of this research is to assess the water quality such as physicochemical parameters, microbial contents and heavy metals of surface water (Ureje river) and ground water samples.

2. Materials and methods

2.1. Materials

All the reagents used for this project were of analytical grade, some of the reagents purchased from Pascal Scientific Laboratory in Nigeria and Sigma Aldrich (UK).

The samples were collected in river and well water from lreje, Ado-Ekiti, Ekiti State.

2.2. Sample Collection

The samples collected were from Ureje river and well in Ireje, Ado-Ekiti, South- West Nigeria. The samples for Physic-chemical analysis were collected in 5 litres plastic bottles which were properly washed three times with distil water and the water from the source. The water sample was at first allowed to run freely for 30seconds without collection. This is to allow for the best representative sample to be taken. The samples for microbial analysis were collected in 1 litre plastic bottle which were properly washed three times with distil water and the water from the source and half-filled. The samples collected were brought to the Department of Chemistry, Federal University of Technology, Akure laboratory for Physicochemical and microbial analysis and kept in a refrigerator with a temperature of about 4°C to preserve before analysis is been perform on the sample.

2.3. Determination of Physicochemical, Microbial Parameters and Heavy Metal Contents of the Water Samples

2.3.1. pH

A pocket pH meter was used to measure the samples' pH in-situ. The water sample was put into a beaker in a certain volume. After being exposed, turned on, and washed with distiller water, the pocket pH meter was put into the sample. The pH meter's displayed value was then recorded.

2.3.2. Temperature

Because it is an in-situ parameter, the temperature of the samples was measured at the point of collection using a pocket thermometer. A certain amount of the sample was put into a beaker. The thermometer was then placed inside of it, where it remained until the thermometer's mercury level reached a steady level. To determine the sample's temperature, this was carried out three times at intervals of two minutes.

2.3.3. Colour

The color if the samples was examined in-situ by personal visualization and was recorded as objectionable.

2.3.4. Electrical Conductivity

Using the FDS/COND. Meter (WINLAB model), which was first calibrated by dipping the EC electrode into 100ml of 0.0lM potassium chloride (KCl) solution, the electrical conductivity of the samples was determined for each one in the lab. The EC value was then calibrated to 1413.00us/m by pressing the CAL button. Then distill water was used to rinse the EC meter electrode, and lastly the water sample. A volumetric flask was used to measure 100ml of the sample, which was then placed into a clean beaker and into which the meter’s electrode was inserted.

2.3.5. Turbidity

The nephelometric method was used to determine the samples' turbidity. The Uniscope UV-Visible spectrometer, which was first calibrated using formazin standard solutions, has a transmittance mode and no wavelength. The samples were stirred up, the air bubbles were allowed to dissipate, and then they were poured into a sterile nephelometer sample tube and put into the instrument's sample chamber. The readings were seen and promptly recorded into the NRUN unit.

2.3.6. Determination of Total Solids (Alpha, 1995)

An uncontaminated evaporating dish was cleaned, dried in the oven for 15 to 20 minutes, and then cooled in desiccators for 30 minutes. The weight of the empty evaporating dish was taken to the nearest 0.001g using the analytical balance. Using pipette, 25ml of well- mixed water sample was measured into the pre-weighed dish and evaporated to dryness on a hot plate. It was ensured that the water sample did not boil. The dish was then dried in the oven at 105°C and cooled in desiccators for 30 minutes and weighed. The processes of drying, cooling, desiccating and weighing was Type equation 1 repeated until weight loss was less than 4% of previous weight or 0.5mg whichever is less

$$\text{Total Solids } ({}^{mg}/_{L}) = \frac{(A-B)x1000}{Volume\ of\ Sample\ (mL)} \qquad 1$$

Where A = weight of dried + dish in mg
B = weight of dish in mg

2.3.7. Determination of Total Suspended Solids (TSS)

The gravimetric method was used to determine the TSS level in the water samples that were collected. 25 ml of completely mixed water sample were put into the pre-weighed glass fiber filter using a pipette. Afterwards, the filter was dried in an oven set at 105°C. In a desiccator, the filter paper was removed, allowed to cool to room temperature, and then weighed to a set weight. Later, the increase in dry filter paper mass was recorded and used to calculate TSS.

TSS is calculated using the formula:

$$\text{Total Solids } ({}^{mg}/_{L}) = \frac{(A-B)x1000}{Volume\ of\ Sample\ (mL)} \qquad 2$$

Where A = weight of the filter after filtration (mg)
B = weight of the filter before filtration (mg)

2.3.8. Determination of Total Dissolve Solids (TDS)

The difference in values between total solids and total suspended solids is a measure of total dissolve Solids. This was done for each of the sample collected.

2.3.9. Biochemical Oxygen Demand (BOD)

The dilution method was used to determine the BOD in the water samples. 10 ml of phosphate buffer, magnesium sulphate, calcium chloride, ferric chloride, sodium sulphite, and ammonium chloride were added to 2 liters of water to make the dilution water. Then water sample (50ml) was measured into a clean standard flask, the sample was topped up with dilution water to 1 L mark of a standard flask. Two 300 mL amber bottle were completely filled with the diluted water. One of the bottles was incubated at 20°c for 5 days. MnSO4 solution, alkali-iodide-azide reagent and concentrated sulphuric acid were added into the second amber bottle. DO in the wastewater sample was derived through iodometric titration. For dissolved oxygen at day zero (DOo), 50 mL aliquot of the solution was titrated against sodium thiosulphate solution using starch solution as indicator, until a colourless end- point was attained. At the end of the 5 days, the sample in the incubator was brought out, dissolved oxygen at day five after incubation (DO_5) was determined by following the same procedure used for the determination of DOo. A blank was prepared in a transparent bottle for DOo. Another blank was prepared in an amber bottle and incubated with the sample for DO_5:

$$BODs(mg/L) = ((\underline{(DO_0 - DO_5)\ x\ Volume\ of\ BOD\ bottle}) / (Volume\ of\ Sample\ (mL))$$

2.4. Dissolved Oxygen (Winkler's Method)

This was done in situ by filling 250ml brown bottle with the sample without bubbles being trapped in 2ml each of MnSO4 and alkaline-iodide solution was added. This was carefully stopped so as to avoid inclusion of air bubbles and thoroughly mixed by rotating and inverting the bottles several times. The precipitate was allowed to settle after which 4ml of conc. Sulphuric acid was added. The solution was thoroughly mixed again and 100ml of the solution was measured into the conical flask. This titrated with 0.025M or 0.0125N $Na_2S_2O_3.5H_2O$ using 2ml of starch as indicator. The colour change of straw yellow to blue was observed at the end point.

$$DO\ (mg/L) = \frac{V1x\ Mx\ 8\ x\ 1000}{V2} \qquad 3$$

V1 = Vol of 0.025M or 0.0125N $Na_2S_2O_3.5H_2O$

V2 = Vol. of the sample taken; M = Molarity of $Na_2S_2O_3.5H_2O$

2.4.1. Determination of Chloride

By measuring 50ml of the sample into a conical flask using a volumetric flask, the quantity of the chloride present in the samples was determined. Calcium carbonate was then added in bit. 1 ml of 5% potassium chromate solution prepared by dissolving 5g if potassium chromate in deionized water and diluted to 100ml was then added as nitrate crystals in 1 dm^3 distilled deionized water was then poured into a burette until it got to the zero reading. The mixture of the sample, $CaCO_3$ and indicator was then titrated against the standard silver nitrate solution ensuring that the mixture was shaken continuously until a permanent reddish-brown precipitate was obtained. The reading of the lower meniscus on the burette was then obtained by subtracting the final reading from the initial reading to obtain the titre value and substituted into the formula below.

$$Cl(mg/L) = \frac{\mathbf{Xx\ M\ x}\ 70900}{\text{Volume of Sample mL}} \qquad 4$$

2.4.2. Total Hardness

The total hardness of the sample were determined by measuring 50ml of the sample using a volumetric flask into a conical flask. 1ml of buffer solution prepared by dissolving lg of borax in 200ml distilled water, 2.5ml of NaOH, Na_2S dissolved in 25ml distilled water and addition of potassium cyanide was added. Two drops of 0.01 M was added as indicator. A pinch of 1ml KCN was added. The solution was shaken together and a wine color was seen. It was titrated against 0.01M EDTA solution ensuring it was shaken continuously until a permanent blue solution was obtained. The reading on the lower meniscus on the burette was observed and recorded. The initial volume of EDTA was subtracted from the final volume and then substituted into the formula below to obtain the quantity of the total hardness present in the sample.

$$\text{Total Hardness (mg/CaC03)} = \frac{\mathbf{Xx\ M\ x}\ 1000}{\text{Volume of Sample mL}} \qquad 5$$

2.4.3. Calcium Hardness

By measuring 100ml of the sample into a conical flask using a volumetric flask, the calcium hardness of the sample was determined. I ml of IM NaOH solution was added. Then NaCl solution was added and the mixture was shaken, a pink solution was obtained. It was then titrated against 0.0IM EDTA solution until a permanent purple solution was seen. The reading on the lower meniscus of the burette was observed and recorded. The initial volume of the EDTA was then subtracted from the final volume and substituted into the formula below to obtain the quantity of calcium hardness present in the sample.

$$Calcium\ hardness = \frac{\mathbf{Xx\ M\ x}\ 1000}{\text{Volume of Sample mL}} \qquad 6$$

2.4.4. Magnesium Hardness

The quantity of magnesium hardness present in the samples were determined by subtracting the quantity of calcium hardness present from the total hardness present

Magnesium Hardness= Total Hardness - Calcium Hardness

2.4.5. Total Alkalinity

Using a titrimetric method, the samples total alkalinity was determined. A volumetric flask was used to measure 50ml of the sample, which was then added to a conical flask. Two drops of methyl orange prepared by dissolving 0.05g methyl orange in 100ml carbon (iv) oxide, distilled water shaken vigorously. 0.02N HCl in one liter of distill water. The solution was then poured into a burette until it got to zero reading and then titrated against the mixture of sample and methyl orange ensuring it was shaken continuously until the colour was seen to have changed completely from yellow to orange. The reading of the lower meniscus on the burette was then observed and recorded. The final titre value was obtained by subtracting the initial volume from the final volume and substituted into the formula below:

$$\text{Total Alkalinity} = \frac{X\ x\ M\ x\ 100000}{Vol.of\ Sample\ (mL)} \qquad 7$$

2.4.6. Total Acidity`

By measuring 50ml of the sample into a conical flask using a volumetric flask, the total acidity of the sample was determined in the lab. One drop of indicator prepared by dissolving 0.lg thymol blue 100ml of 5% ethanol and mixed in the ratio 1:3 of thymol blue and phenolphthalein added. The mixture was then titrated against 0.1 M NaOH prepared by dissolving 4g NaOH in 250ml beaker, transferred into one litre standard flask and made up with distilled water. This was done ensuring that the solution was shaken continuously until colourless solution was obtained. The reading of the lower meniscus on the burette was observed and recorded. To calculate the sample's total acidity, the initial volume of NaOH was subtracted from the final volume and substituted into the formula below.

$$\text{Total Alkalinity} = \frac{XxMx100000}{Vol.of\ Sample\ (mL)}$$

2.4.7. Determination of Sulphate (Colorimetric method)

Sulphate stock standard solution of l000mg/1 was prepared by dissolving 1.479g of anhydrous Na2SO4 in 500ml of distilled water in 1000ml size volumetric flask. The flask was later filled up with distilled water. From the stock solution, lower concentrations of 2.00, 4.00, 6.00, 8.00 and 10.00mg/l in 100ml volumetric flask were prepared by employing serial dilution method (CtV1 = C2V2). Reagent blank was also prepared, 70ml of each standard solution was measured into the volumetric flask and was thoroughly shaken with the addition of 10ml of Alcohol-Glycerol mixture and finally 5.0g of finely divided BaCl crystal was added and the volume was filled to mark. The absorbance of the reagent blank and standards were taken with Uniscope UV-spectrophotometer between the wavelength (λ) 380-420nm. The absorbance was plotted against standard concentrations and a calibration graph was obtained. The concentration of the sample was known from the above procedures. Linear regression equation was applied to compute the concentration.

2.4.8. Determination of Nitrate (Colorimetric method)

The calibration standards of the range 0.1 to l.0mg/1 were prepared by diluting appropriate volume to 50ml. One sachet of the Nitraver 5 powder pillow was added to 10ml of each standard into different volumetric flasks. The solution was thoroughly shaken, allowed to stand for 5 minutes after which amber colour developed. The absorbance was determined at 540nm and distilled water was used as blank. A calibration was obtained as in sulphate and phosphate determination. The same procedure was carried out on sample and the absorbance of the sample was obtained.

2.4.9. Determination of Heavy metals

By measuring 50ml of the acidified sample using a volumetric flask and pouring it into a conical flask, heavy metals present in the samples were determined in the lab. Then, 5ml of concentrated nitric acid was added, and the mixture was cooked in an electrical cooker for 15 minutes until it reached 60^0C. The conical flask was then brought down and allowed to cook. 20ml of distilled water and nitric acid was added and it was then filtered using a filtered paper and a funnel. The filtrate obtained was then made up to 100ml inside I00ml sample bottle by adding distill water. The sample was then finally analyzed for zinc, Iron, Copper, Lead and Cadmium, using the atomic absorption spectrometer (Varian model spectral AA 220) and then recorded.

2.4.10. Bacteriological Analysis

Spread plate technique was used for the bacterial analysis. The prepared sterilized medium (macconkey agar) was added to a glass petri dish, into which l cm3 of the water sample was transferred. The contents of the petri dish were gently stirred, cooled, and then placed in the incubator for 24 hours at 35 °C. Durham tubes were employed for coliform direction. The multiple tube fermentation technique was used to calculate the total coliform counts in the samples. A Suwtex 560 colony counter was used to count the colonies after inoculating several fermentation tubes containing MacConkey broth with 1 cm3 of water samples at 37 °C for 24 hours. The presumptive and confirmative tests were used to find *E. coli* in the water.

3. Results and discussion

The result of Physicochemical Properties of the river and well water samples in Ireje, Ado-Ekiti were shown in the Table 1 below.

The results of physicochemical properties of river and well water samples in Ireje, Ado-Ekiti compared with the World Health Organization (WHO, 2003) standards for drinking were indicated in the Table1 above. The quality of the river and well water was determined in terms of the mean values of physicochemical parameters which were compared with

World Health Organization (WHO) recommended limits for proper functioning of the biological systems of human beings.

The physical parameters of both sample A and sample B were within the WHO standard for drinking except the conductivity of both samples and the colour for sample A which is slightly coloured and might be due to clay soil through which the river had flown through. The increase in conductivity is because water evaporates during the dry season and concentration of ions increases hence electrical conductivity increases. This high conductivity level of the ground and surface water samples indicate electrolyte contaminants but, do not give information of a specific chemical (Adekunle et al., 2007).

Table 1 Physicochemical Properties of the river and well water samples

Parameters	**Sample A**	**Sample B**	**WHO**
	Mean/(STD)	**Mean/(STD)**	
Colour	Objectionable	Unobjectionable	Unobjectionable
Odour	Unobjectionable	Unobjectionable	Unobjectionable
Temperature (°C)	26.60(±0.10)	26.60(±0.20)	25-30
pH	8.93(±0.024)	7.93(±0.01)	6.5 - 8.5
Turbidity (NTU)	1.54(±0.03)	1.35(±0.02)	5.0
Total Alkalinity (mg/L)	56.00(±2.00)	36.00(±2.00)	600
Total Acidity (mg/L)	93.33(±11.54)	266.66(±10.54)	
Conductivity (µs/cm)	336.00(±4.35)	362.33(±1.52)	250
Total Hardness (mg/L)	1.48(±0.031)	1.72(±0.04)	150 – 500
Ca^{2+} Hardness (mg/L)	0.97(±0.01)	1.01(±0.01)	
Mg^{2}+ Hardness (mg/L)	0.51(±0.036)	0.71(±0.05)	
DO (mg/L)	3.86(±0.11)	3.53(±0.11)	7.5
BOD(mg/L)	2.66(±1.05)	1.66(±0.5)	2.0 - 6.0
TS(mg/L)	48.30(±0.057)	30.00(±1.00)	
TDS(mg/L)	40.00(±0.10)	26.0(±1.05)	250-500
TSS (mg/L)	8.30(±0.057)	4.00(±0.14)	
Chloride (mg/L)	92.16(±1.41)	122.89(±2.16)	250.00
Sulphate (mg/L)	49.13(±0.90)	27.26(±0.24)	500.00
Nitrate (mg/L)	3.87(±0.045)	1.88(±0.025)	10.00

pH is the measure of degree of acidity or alkalinity of a substance. The pH is an important factor that determines the corrosive level of water. Sample A and sample B were found to have a pH of 8.83(±0.024) and 7.93(±0.01) respectively. The value of sample A was slightly higher than that of sample B. Both samples were within the allowable WHO, (2015) standard limits (6.5- 8.5). The pH value of both samples was a bit lower when compared to 5.90-7.60 reported by Adeyeye and Abulude (2004).

The results indicated that sample A were found to have a total alkalinity of 56.00(±2.00) mg/L while sample B were found to have a total alkalinity of 36.00(±2.00) mg/L. This result indicated that the total alkalinity of Sample A is higher than that of sample B. Both sample A and sample B were below the allowable WHO, (2015) standard limits (650 mg/L). The value of total alkalinity obtained in this study is in agreement with what was reported by (Salaudeen, 2016). Alkalinity therefore acts as a stabiliser for the acidity present in the water and also helps in application of proper dose of chemical in wastewater treatment processes such in coagulation, anaerobic digestion control and softening of the

water (Adefemi & Awokunmi, 2010). Therefore, low Alkalinity of the both samples indicated that both samples are slightly acidic but sample B is more acidic than sample A.

The water sample for A has a total acidity of 93.33(±11.54) mg/L while that of Sample B has a value of 266.66(±10.54) mg/L, both samples were above the WHO standard for drinking. The total acidity value for sample is much lower than that of sample B. The value of total acidity obtained for both sample is in agreement with what was reported by (Richard & Ibiyinka, 2016). High acidity in water causes harm to the body and also acidic water can corrode pipes. Water acidity is defined as the capacity to react with a strong base up to a given pH value. The acidification of freshwater in an area is dependent on the quantity of calcium carbonate (limestone) in the soil. Limestone can buffer (neutralize) the acidification of freshwater. The effects of acid deposition are much greater on lakes with little buffering capacity.

The value of Total solids of Sample A and Sample B were 48.30(±0.057) mg/L and 30.00(±1.00) mg/L respectively, which were within the allowable WHO, standard limits. the value of sample A is higher than that of sample B. Each sample was a bit higher with the value reported by (Salaudeen, 2016). Total solids are composed of all the suspended, colloidal and dissolved solids in the sample. A high total solids level indicates that there is a high level of solid material in the liquid sample. Depending on the evaluation criteria, a high level of total solids could cause the sample to be considered contaminated.

The total dissolved solids of Sample A and Sample B were 40.00(±0.10) and 26. 00(±1.05) mg/L respectively, which were within the allowable WHO, standard limits (500 mg/L). the value of sample A is higher than that of sample B. Each sample was in agreement with the value reported by (Salaudeen, 2016). The total dissolved solids test provides a qualitative measure of the amount of dissolved ions but does not tell us the nature or ion relationships and therefore total dissolved solids test is used as an indicator test to determine the general quality of the water.

The total suspended solids of Sample A and Sample B were 8.30(±0.10) and 4.00(±1.05) mg/L respectively, which were within the allowable WHO, standard limits. The value of total suspended solids obtained for both Sample A and sample B is in agreement with what was reported by (Salaudeen, 2016). The presence of materials suspended in the stream was indicated by high levels of Total Suspended Solids (TSS) in water sample indicating that the river was polluted (Amadi et al., 2006). Total suspended solids may have been due to changes in season, pH and temperature affecting weathering processes, formation of complex compounds, coagulation and sorption processes occurring in the flow water sources.

Both Sample A and Sample B have a Total hardness of 1.48(±0.031) and 1.72(±0.04) mg/L respectively which were within the allowable WHO, standard limits (500mg/L).

The value obtained for Sample A is a bit lower than that of sample B. The value of total hardness obtained for both sample is lower compared to what was reported by (Salaudeen, 2016) and (Richard & Ibiyinka, 2016). Hardness determines if the water is hard or soft. Waters become hard primarily due to excessive presence of bicarbonate, chloride and dissolved sulphate in water (Saksena et al., 2008).

Calcium is an important constituent of bones, teeth, enzyme cofactor and calcium also serve an important role in the health of bodies of water. The value of calcium and magnesium concentrations in the river water sample were 0.97(±0.01) and 0.51(±0.036) mg/L respectively and 1.01(±0.01) and 0.71(±0.05) mg/L for well water sample respectively. This result indicated that the value of calcium and magnesium for both samples were within the WHO recommended standard for portable water. The value of each sample was a bit lower with the value reported by both (Salaudeen, 2016) and (Richard & Ibiyinka, 2016). Excessive magnesium in potable water may give water a bitter taste but it is not usually a health hazard. However, excessive calcium in water could give rise to kidney disorder from the formation kidney and bladder stones.

The concentration of chloride in Sample A and Sample B were found to be 92.16(±1.41) and 122.89(±2.16) mg/L respectively, which were within the allowable WHO, standard limits (250 mg/L). When compared sample A is much lower than sample B. Each sample was in agreement with the value reported by (Salaudeen, 2016). This is an indication that there is minimal chloride pollution of both water samples. Chloride concentration in water indicates presence of organic waste particularly of animal origin (Saksena et al., 2008). Chloride is generally not considered a health risk but at relatively low concentrations this ion in drinking water can affect its taste, however, a high chloride intake can result in high levels of chloride in the bloodstream that is hyperchloremia.

Both Sample A and Sample B have a dissolved oxygen concentration of 3.86(±0.11) and 3.53(±0.11) mg/L respectively, which were within the maximum limits of 7.5 mg/L set by WHO (Geneva, 2011). The value for sample A is a bit higher

than that of sample B. The low dissolved oxygen in sample B could be attributed to the discharge of organic wastes, nutrient inputs from untreated sewages, decayed plant and animal materials flowing through to the ground water (Nkwoji et al., 2019). The DO value of both samples was a bit higher when compared to 2.1-4.5 mg/L reported by Nkwoji et al., (2019). The DO concentration gives an indication of the relative availability of dissolved oxygen in the river and its availability to support life through aerobic respiration. Therefore, shows a slightly low pollution of both the river and well water and minimal treatment will be required to get rid of the organic pollutants contained in the water.

The concentration of sulphate in Sample A and Sample B were found to be 49.13(±0.90) and 27.26(±0.24) mg/L respectively which were within the allowable WHO, standard limits (500 mg/L). the value of sample A is higher than that of sample B when compared. The value of sulphate obtained for both samples is higher compared to what was reported by (Richard & Ibiyinka, 2016). Sulphate is naturally present in water as SO4. It is stable and oxidized form of sulphur and is readily soluble in water. Sulphur is an essential plant nutrient and also aquatic organisms utilized sulphur for growth.

The concentration of nitrate in Sample A and Sample B were found to be 3.87(±0.045) and 1.88(±0.025) mg/L respectively which were within than the allowable WHO, standard limits (10 mg/L). the value of sample A is a bit higher than that of sample B. The value of nitrate obtained for both samples is a bit lower than what was reported by (Istifanus et al., 2013). Nitrate is composed of the element's oxygen and nitrogen, and is an important source of nitrogen for plant and animal life; but too much nitrate in drinking water can be harmful to human health. Consuming too much nitrate can be harmful especially for kids. Consuming too much nitrate can affect how blood carries oxygen and can cause methemoglobinemia (also known as blue baby syndrome).

The BOD value of Sample A was 2.66(±1.05) mg/L which was within the range of WHO standard limits (2-6 mg/L) and Sample B was 1.66(±0.5) mg/L which was also within the allowable WHO, standard limits (2-6 mg/L). The value of sample A is a bit higher than that of B when each sample was compared. The value of biological oxygen demand for both samples in this study is in agreement with what was reported by (Salaudeen, 2016). Biochemical oxygen demand (BOD) is the number of oxygen microorganisms take to decompose organic waste matter in water. It is therefore used as a measure of the number of certain types of organic pollutants in water. The BOD value indicates the extent of organic matter pollution and the concomitant treatment process that will be required to get rid of the pollutants. If the water is polluted, more will be the BOD as more will be the organic matter present in it, and hence, more oxygen will be required to decompose it. Hence, BOD in river water will increase if sewage gets mixed up with the river water because the organic matter will be added to the river.

The results of the physicochemical parameters obtained in this study implies that all the physicochemical parameters in the river water are within the allowable WHO standard limits except conductivity which is a bit higher. Therefore, proper treatment of the river and well water is required before consumption and domestic uses.

3.1. Heavy Metals of River and Well Water Samples

The result of Heavy metals of the river and well water samples in Ireje, Ado-Ekiti were shown in the Table 2 below.

Table 2 The results of Heavy metals of the river and well water samples

Parameter (mg/L)	Sample A	Sample B	WHO
	Mean/(STD}	Mean/(STD}	
Cupper	0.78(±0.051)	0.141(±0.0015)	1.00
Chromium	0.048(±0.0025)	0.014(±0.014)	0.05
Lead	0.011(±0.0015)	BDL	0.01
Manganese	0.53(±0.01)	0.07(±0.002)	0.20
Iron	1.84(±0.021)	0.54(±0.0055)	0.30
Cadmium	0.006(±0.0007)	BDL	0.003
Zinc	1.70(±0.014)	0.63(±0.003)	3.00

Table 2 above indicate the results of heavy metals of river and well water samples in Ireje, Ado-Ekiti compared with the World Health Organization (WHO, 2003) standards for drinking water.

The concentration of copper in sample A and sample B were found to be 0.78(±0.051) and 0.141(±0.0015) mg/L respectively which were within the allowable WHO, standard limits (1.00 mg/L). The value of sample A is a bit higher than that of sample B. Copper is an essential nutrient at low concentrations, but is toxic to aquatic organisms at higher concentrations. In addition to acute effects such as mortality, chronic exposure to copper can lead to adverse effects on survival, growth, reproduction as well as alterations of brain function, enzyme activity, blood chemistry, and metabolism. Eating or drinking too much copper can cause vomiting, diarrhea, stomach cramps, nausea, liver damage, and kidney disease. The value of copper obtained in this study is in agreement with what was reported by (Richard & Ibiyinka, 2016), however, the value obtained is lower compared with what was reported by (Istifanus, et al., 2013).

The concentration of chromium in Sample A and Sample B were found to be 0.048(±0.0025) and 0.014(±0.014) mg/L respectively which were within than the allowable WHO, standard limits (0.05 mg/L). The value of sample A is a bit higher than that of sample B. Each sample was a bit lower with what was reported by (Odeyemi, 2010). In human body, chromium metal act as an essential part of metabolic processes that regulates sugar level in blood, and helps insulin transport glucose into cells, where it can be used for energy. A very little amount of chromium is needed by our body. Due to its involvement in metabolism of fats, proteins, carbohydrate, carbs and other nutrients, chromium also plays a role in preventing cardiovascular disease. Chromium based deficiency include symptoms like, irregular blood glucose, fatigue, high cholesterol, anxiety etc.

The concentration of lead in Sample A and Sample B were found to be 0.011(±0.0015) and BDL (Below Detection Level) respectively which were within than the allowable WHO, standard limits (0.01 mg/L). The value of sample A is a bit higher than that of sample B. The value obtained for both samples is a bit higher compared with what was reported by (Richard & Ibiyinka, 2016). However, excess amount of lead creates harmful effect on health and it can directly destroy the major organs and system of body. Kidney failure, haematopoietic, cardiovascular diseases, nervous disorder, effect on immunological system these are the most common diseases due to interaction of lead. The concentration of manganese in Sample A and Sample B were found to be 0.53(±0.01) and 0.07(±0.002) mg/L respectively. Sample B is within than the allowable WHO, standard limits (0.20 mg/L) while sample A is a bit higher compared to WHO standard. Sample A is a bit higher than sample B. The value of manganese obtained for both samples is a bit higher compared with what was reported by (Istifanus, et al., 2013). Manganese is an important trace mineral that is needed by our body in little amounts for the production of digestive enzymes, absorption of nutrients, wound healing, bone development and immune-system defenses. Negative health effects can be caused by insufficient or excessive intake of manganese. A deficiency can cause serious health problems including weak bones (osteoporosis), muscle and joint pain, and sexual dysfunction. Human exposure to higher amount of manganese can result severe disorders in nervous system.

The concentration of iron in Sample A and Sample B were found to be 1.84(±0.021) and 0.54(±0.0055) mg/L respectively. The value of sample A is a bit higher than that of sample B. The concentration of iron for both samples is higher than WHO standard for drinking (0.30 mg/L). The value obtained for both samples is lower compared with what was reported by (Istifanus, et al., 2013). Higher concentration of iron is very harmful to human health because higher concentration of iron in water causes; Stains on your home appliances, can cause damage to Pipes, effects on food and beverage (Iron in drinking water causes it to develop an unpleasant metallic smell and taste). However, Iron (Fe) is an essential element for human health that performs various functions in our body, the most well-known of them is production of protein haemoglobin, which carries oxygen from our lungs to transfer it throughout the body.

The concentration of cadmium in Sample A and Sample B were found to be 0.006(±0.0007) and BDL respectively which were within than the allowable WHO, standard limits (0.003 mg/L). The value of sample A is a bit higher than sample B. Both samples value obtained during this study is lower compared with what was reported by (Srikanth et al., 2013,). A deep exposure to significantly higher cadmium levels can lead to a variety of negative health effects including; diarrhoea, vomiting, fever, lungs damage, muscle pain (Nordberg, 2004). While some diseases appear by continuous intake of cadmium, like kidney disorder and bone damage, reproductive problem and possibly even cancer.

The concentration of zinc in Sample A and Sample B were found to be 1.70(±0.014) and 0.63(±0.003) mg/L respectively which were within than the allowable WHO, standard limits (3.00 mg/L). Sample A is a bit higher than sample B. The value obtained for both samples was in agreement with what was reported by (Odoh Raphael et al., 2018). Zinc helps in production of hormones, growths, improvement of immune and digestive system. Increased Zinc can result distinguished health problems such as stomach cramps, skin inflammation, vomiting, nausea, anaemia, root trouble in pancreas, protein metabolism and further it can generate arteriosclerosis. Zinc deficiency can lead to fertility issue and also increase the risk of diabetes.

The results of the heavy metals concentrations obtained in this study implies that Zinc, Chromium, Lead, Cadmium and Zinc are all within the acceptable range of WHO standards for drinking water. But the concentrations Iron and

Manganese are above the range of drinking water standards set by WHO. Therefore, proper treatment of the river and well water is required befo.-e consumption and domestic uses.

3.2. Microbial Parameter of River and Well Water Samples

The result of Microbial parameter results of river and well water samples in Ireje, Ado-Ekiti were shown in the Table

Table 3 Microbial parameter results of river and well water samples

Organism (cfu ml)	Sample A	Sample B	Standard
Total Viable Counts	462	26	$1xl0^3$
E.coli	0	0	0
Faecal streptococci	0	0	0
Coliform	64	2	0
Pseudomonas aeruginosa	0	0	0
Yeast/mould	45	8	$1 x l0^3$

The results of microbial analysis of river and well water samples in lreje, Ado-Ekiti compared with the World Health Organization (WHO, 2003) standards for drinking water was indicated above:

The total viable count in the water for both sample A and sample B were 462 cfu/ml and 26 cfu/ml respectively. Both samples result were within the allowable WHO standard, although sample A is much higher than sample B due to fact that the river water is more polluted with microorganisms than the well water. Total viable count (TVC), gives a quantitative estimate of the concentration of microorganisms such as bacteria, yeast or mould spores in a sample. The count represents the number of colonies forming units (cfu) per g (or per ml) of the water sample. This value indicated that the microbial content in the water is high and it makes the water in a high risk for consumption and also decrease the quality of the water also high TVC so count indicates a high concentration of micro-organisms which may indicate poor quality for drinking water. The value of total viable count obtained for both samples in this study is higher compared with what was reported by (Richard & Ibiyinka, 2016), however, the value obtained is also higher compared to what was reported by (Abideen et al., 2020).

The water sample A and sample B has a coliform value of 64 cfu/ml and 2 cfu/ml respectively which were higher than the allowable WHO standard limits. The coliform value of sample A is much higher than that of sample B. Coliform bacteria are organisms that are present in the environment and in the faeces of all warm-blooded animals and humans. Coliform bacteria will not likely cause illness. However, their presence in drinking water indicates that disease- causing organisms (pathogens) could be in the water body. Most pathogens that can contaminate water supplies come from the faeces of humans or animals. Symptoms of coliform bacteria may include gastrointestinal illnesses such as severe diarrhoea, nausea, and possibly jaundice as well as associated headaches and fatigue. The value of coliform obtained for both samples is lower than what was reported by (Istifaous et al., 20I3).

Both sample A and sample B has a yeast/mould value of 45 cfu/ml and 8 cfu/ml respectively which were within the allowable WHO standard limits. The coliform value of sample A is much higher than that of sample B. The value of yeast/mould obtained for both samples is higher than what was reported by (Abideen et al., 2020). Yeasts and moulds are two different forms of naturally occurring fungi present in the environment. Mould and yeast cause diseases such as candidiasis, aspergillosis.

No value was detected for *E. coli*, *Faecal streptococci* and *Pseudomonas aeruginosa* for both river and well water samples. Therefore, both samples were within the WHO standard for *E. coli, Faecal streptococci* and *Pseudomonas aeruginosa*. *E. coli* in water is a strong indicator of sewage or animal waste contamination. Sewage and animal waste can contain many types of disease-causing organisms. *Faecal streptococci* or enterococci are considered as Streptococcus spp. Faecal pollution is the major cause of waterborne disease, since most of the pathogens associated with transmission reside in human and warm-blooded animal faeces. *Pseudomonas aeruginosa* in the water cause urinary tract infections, respiratory system infections, dermatitis, soft tissue infections, bacteraemia, bone and joint infections, gastrointestinal infections and a variety of systemic infection

The results obtained in this study indicated that, *Faecal streptococci*, *Pseudomonas aeruginosa*, and *E. coli* are not present and within the WHO standard. However, some pathogenic bacteria and fungi such as coliforms, yeast and moulds are present in little quantity in the water sample. Therefore, proper treatment of both river and well water should be done before consumption and domestic uses.

The studied research assessed the physicochemical properties, heavy metals and microbiological parameter of river and well water samples in Ireje, Adio-Ekiti, South-West Nigeria. The analysis was carried out by taking certain important parameters like pH, Temperature, electrical conductivity, total dissolved solids, BOD, DO, turbidity, total alkalinity, total hardness, sulphate, chloride, nitrate, calcium, magnesium, iron, lead, cadmium, copper, chromium, manganese, zinc, coliform, yeast/mould*, E. coli*, *Faecal streptococci*, *pseudomonads aeruginosa* and so on. In this present investigation, it was found that the physicochemical, heavy metals and microbial parameters for both river and well water were within the WHO standard for water limits while the colour of the river, the conductivity, iron, manganese, yeast/mould and coliform of both river and well water were above the WHO permissible limits. Specifically, this study shows that the surface water (Ureje river water) and ground water (Well water) is polluted with contaminants which is not safe for human use, to make it fit for human use and commercial purposes, it is needed to be treated properly.

4. Conclusion

The research shown that some of the physical parameters were above the WHO permissible limits. Besides the microbial contents such as total viable count, yeast/mold and coliform were above the WHO permissible limits for drinking. These results show that the water sources were slightly contaminated and unsafe for human consumption. This water must be treated before it may be consumed or used for domestic application.

Compliance with ethical standards

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Disclosure of conflict of interest

Authors have declared that no competing interest exist.

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