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EVALUATION OF THE PHYSIOCHEMICAL AND BACTERIOLOGICAL CONTENTS OF UNWANA – BEACH RIVER WATER UNWANA, NIGERIA FOR POTABILITY.

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Abstract - This work covered the determination of the physiochemical and bacteriological contents of Unwana Beach River water for potability. Eight (8) water samples were collected from eight (8) different locations in the river. The physiochemical parameters analyzed were Total Dissolved Solids (TDS), Total Suspended Solids (TSS), Turbidity, Carbonate Hardness, Nitrate (NO_3), Nitrite (NO_2), and pH. While the bacteriological parameters analyzed were E. coli, and microbial count (TCC). The results obtained showed varying concentrations with locations of sampling of water. The mean concentration of the TDS, Carbonate Hardness, NO_3, NO_2, and pH in water samples were 424.75 mg/l, 310.25 mg/l, 17.8 mg/l, 0.18 mg/l, and 7.58 respectively which were within (NSDWQ 2017) and (WHO 2015) standards while the mean concentrations of TSS, Turbidity, and Iron were 84.75 mg/l, 10.88 NTU and 0.38 mg/l respectively and were slightly above (NSDWQ 2017) and (WHO 2015) standards. Also, the mean concentration of E. coli was 3.25 cfu/ml which was above (NSDWQ 2017) and (WHO 2015) standards while the mean concentration of Total Coliform Count (TCC) was found to be 6.0 cfu/ml which was below (NSDWQ 2017) and above (WHO 2015) standards. The presence of E. coli in the water indicated recent fecal contamination due to surface runoff inflows into the river during rainfalls which may be carrying human or animal excreta, and this suggested that the water required physiochemical and bacteriological treatment to enhance its suitability for domestic and other uses.

Keywords: Physiochemical, Bacteriological, Contaminants, E.coli, Nitrate

1. Introduction

Water is a vital resource in the universe that can be replenished and is required for the existence and sustenance of life, food production, economic development, and the total content of life. Water is difficult to substitute because of its unique functions. It is difficult to cleanse, and it is certainly a unique gift from nature to humans. Getting fresh and contaminant-free water is a major concern. The fresh-to-saline water ratio on Earth is 1 to 50. Freshwater accounts for only 3% of the earth's surface. Among the water classified as non-saline water on the earth's surface, 5% flows in rivers and streams, 65% as ice and glaciers, and 30% as groundwater. The available freshwater goes into activities such as domestic (10%), industrial (20%), and agricultural (70%) uses. For this water to be used for any purpose, the level of contamination of the water must be ascertained for its suitability for that purpose.

Therefore, water quality is a crucial concern to humans as it is directly connected to human welfare and health. Portable water is water that is adequately safe to be consumed by human beings or used with a small risk of long-term or immediate havoc to man (Punmia, 2018).

Drinking water that is safe for humans should be completely free from microorganisms like viruses, bacteria, and parasites. It should also meet established standards for odor, appearance, and chemical concentrations. It should also be available in sufficient amounts to meet domestic purposes (Skerman, 2018). Typically, water uses other than potable purposes include washing clothes, bathing, toilet flushing, farm irrigation, and so on. it is only three percent (3%) out of the total amount of water available that is fresh and out of this three percent of fresh water that is available, only 3/4 of it is accessible to man for use. However, research has shown that by the year 2025, water scarcity will increase due to pollution by human activities (Punmia, 2018).

Contaminated water generally refers to water that does not meet the stipulated standards such as (WHO 2015) and (NSDWQ 2017) standards. Water quality standards differ from country to country, although (WHO 2015) has an approved standard to be adopted globally.

Pollution of Water: Water pollution as a phenomenon occurs as a result of human activities that contaminate water sources such as seas, oceans, lakes, aquifers, rivers, and groundwater, thus changing their physical, chemical, and microbial properties which eventually leads to life-threatening issues to humans, animals, ecosystem and the environment (Anijiofor-Ike, 2023). Water pollution results from different sources which include carcasses, oil spills, bacteria, fecal matter, or chemicals.

Overuse of water

The misuse of water by humans is of serious concern and worrisome to many people. Water sometimes becomes overused during recreational activities and also during irrigation of farmland without concern about its effects on the environment (Akinola, 2017).

Drought

Drought is referred to as the condition of an area not having sufficient rainfall to recharge the water used. Some areas are in constant and continuous drought while other areas may be experiencing drought occasionally. There is little that can be done to prevent the occurrence of drought as it is a natural phenomenon (Sunday et. al., 2019)

Water quality

According to Onyeabor and Elechi (2017), drought characterizes the state of water, including its chemical, physical, and microbial properties to its suitability for certain purposes like drinking, or bathing. Numerous parameters including the amount of dissolved oxygen, bacteria prevalence, salinity or salt content, and the amount of suspended solids are used to estimate water quality. According to Onyeabor and Elechi (2017), the quantity of tiny algae, as well as the amount of herbicides, pesticides, heavy metals, and other pollutants, could be assessed in particular water bodies to determine their quality. Water contamination falls into three basic categories which include.

1. Physical contamination: These include total solids, tastes, odors, colors (both natural and manmade), sediments, dirt, sand, or particles that can alter tastes and minerals.

2. Biological contamination: These refer to pathogens with serious or direct impacts on human health such as bacteria like E. coli, salmonella, shigella, and legionella, as well as parasites like tapeworm and viruses like poliovirus and hepatitis A.

3. Chemical contamination: These include volatile organic molecules, chloramines, chlorine, herbicides, pesticides, and inorganic chemicals such as nitrates.

Dissolved solids: Minerals including both magnesium and calcium, and metals like lead, iron, manganese, and mercury are examples of dissolved solids.

From this review, it is posited that the portability of water is not only measured in its physical appearance but also some laboratory investigatory steps are considered necessary to ascertain the chemical and bacteriological contents of the water sampled and thereby ascertain the potability of the water. This is achieved by providing and using recommended testing apparatus following specified procedures and paying strict attention to stipulated guidelines and standards.

2.0 Water Quality Review

The quality of Water is a measure that describes the acceptability of water for different industrial and domestic uses. Water quality is influenced by both human and natural causes. Geological, hydrological, and climatic are the most significant natural effects as they have a direct influence on the quantity and quality of accessible and usable water.

Accurate data on water quality is essential for developing public policy and implementing water quality improvement programs. The water quality index (WQI) is a measure that summarizes information concerning the quality of water. WQI is a regularly used method for estimating and evaluating water contamination and it may be described as an indicator of the combined effects of multiple water quality parameters on the total quality of water (Trivedi et. al., 2020). Physiochemical index and microbial index are the two main categories of WQI indices. The physiochemical index is based on the amounts of different physiochemical parameters in a sample of water while microbial index is a derivative of microbial information available.

2.1 Water Quality Monitoring

Field evaluations, collection and examination of water samples, the study and assessment of analytical results, and reporting and presentation of results are the major components of water quality monitoring. Also, baseline monitoring, ambient monitoring, and compliance monitoring are some of the common water quality monitoring strategies.

2.2 Effects of Natural Processes on Water Quality

Degradation is practically undoubtedly the effect of man's activities which affect water quality. Some natural occurrences such as hurricanes and torrential rainfall are potential causes of undue landsides and erosion in lakes and rivers where they occur, and these can result in water quality contamination (Bisi, 2017). An increase in dissolved oxygen can be brought about by seasonal overflows in lakes and rivers to the surface. This is a natural occurrence that may be regular or occasional. A consistent natural occurrence in specific regions could affect water quality especially for consumption and to some extent for irrigation purposes (Edema et. al., 2016). Furthermore, the composition of freshwater such as chemical, physical, biological, and hydrological is likely subject to changes by different types of natural occurrences (Bisi, 2017). Some chemical elements may be found in only trace quantities in solution due to their strong attraction to particles and due to dissolution and adsorption reactions. However, other components are more soluble and are rarely contained in water that is in particle form. Also, the ability of a chemical to appear in soluble form rather than in particles is described as the Soluble Transport Index (STI) of the chemical. According to Mohson et. al., 2019, the geological characteristics of a basin can lead to a large disparity in the amount of trace elements in particles and the one within a particular water body quality which can also vary with time and place. Also, point sources originate from a pipe or other specific point of discharge that represents a certain location. On the other hand, non-point sources are more diffuse and have several origins and diverse routes through which pollutants can enter surface and ground waters. This is usually very difficult to identify, control, and monitor in urban wastewater (Shally et. al., 2016). In addition, agricultural and urban runoff, hazardous waste facilities, industrial discharges, mine drainage, oil spills, and accidental releases are examples of point sources. Point discharges connected with a utility facility are generally controlled. The effect of wastewater on rivers and streams is a function of the stream's ability to assimilate contaminants and describes such assimilative capacity of a stream as the stream's ability for self-purification (Mohson et. al., 2019). On the other hand, discharges from wastewater are a main source of nutrients, parasites, bacteria, viruses, and chemical pollution to the receiving water course. Discharge of untreated wastewater with high levels of nitrogen and ammonia may support algal growth in water bodies.

2.3 Salmonella

Salmonella belongs to the Enterobacteriaceae family, and it is subdivided into four subgenera based on biochemical characteristics. The majority of salmonella that are strains isolated from humans and warm-blooded vertebrates belong to subgenus I, while subgenera II, III (also known as Arizona), and IV are more commonly related with reptiles in which they reside in common. Currently, over 2000 species are named. These are significant regional differences in the occurrence of serotypes. Salmonella pathogenicity is determined by the serotype and strain specification in the host range as well as the infectious dose and host condition (Agbazue et. al., 2017).

2.4 Yersinia

The genus Yersinia is now classified as Enterobacteriaceae and includes seven species. Y.pestis, Y.pseudo tuberculosis, and certain serotypes of Y.enterocolitica are human pathogens (Skerman, 2018). Y. enterocolitica – organisms are kinds of Y.enterocolitica strain that are commonly recovered from environmental materials. They are non–pathogenic to humans and can be biochemically classified as Y.frederiksenii, Y.kristensenii, and Y.aldovae.

2.5 Campylobacter

In recent years, campylobacter spp. has received a lot of attention as a key cause of enteritis, gastritis, and other infections of man. Campylobacter is Gram-negative, thin, and comma-shaped rods. When paired, they look S-shaped and gull-winged. The organisms move in a characteristics corkscrew–like pattern, which is easy to observe under a phase–contractor microscope. Campylobacters as microaerophilic organisms require minor oxygen concentration (3 – 6%) to develop (Maaike et. al., 2019). Cells can develop coccid bodies in unfavorable growth conditions. A recent WHO 2015 assessment covers 17 campylobacter species. Some campylobacters are humans and animal pathogens (e.g C.jejuni, C.coli, C.fetus) while others deemed non – pathogenic (e.g. C.sputorum, C.concisus).

2.6 Escherichia coli

Escherichia coli, also known as E.coli are seen in large amount in the human excreta and practically that of all warm-blooded animals and hence is an indicator of recent faecal pollution of water; (WHO 2015). Confirmation tests for E.coli include β - glucuronidase, Gram staining, and absence of urease activity. E.coli is a Gram-negative, non – spore-forming, rod-shaped bacterium that can be motile or non–motile. It grows aerobically or facultatively. Metabolism involves both respiratory and fermentative processes (Swason and Hammer, 2016).

Health Effects.

E.coli is a common intestinal bacterium and majorly of strains that are non – pathogenic. However, subtypes capable of causing gastrointestinal disease are also noticed. These pathogenic E.coli strains induce intestinal disease through several methods. Salmonella-caused infections can look like cholera, dysentery, or gastroenteritis. Four types of pathogenic E. coli cause diarrhea: enteroinvasive, enteropathogenic, and enterotoxigenic. The first enteropathogenic subtypes of E. coli were identified through serological investigation of strains isolated from newborn diarrhea outbreaks. Although specific serotypes have been linked to disease, the underlying pathogenic mechanisms for the majority of these pathogens remain unknown. These strains are particularly linked to epidemics of infantile gastroenteritis.

2.7 Total Dissolved Solids (TDS)

Total Dissolved Solids (TDS) are reasonably connected with the aggregate mineral content in water (residues remaining after evaporation of a water sample), which consists mostly of salts, carbonates, and metals. Dissolved solids can also be organic compounds. A high TDS content indicates a potential high amount of pollution, and further investigation could be necessary.

2.8 Total Suspended Solids (TSS)

When it rains, Total Suspended Solids (TSS) are released from cultivated fields, farmlands, building and logging sites, eroded stream banks, and strip-mined land. As these deposits enter the lakes, rivers, coastal waterways, wetlands, and rivers, they impair fish respiration and limit plant productivity and water depth. Aquatic life is smothered, reducing the aesthetic of the water (Chigor et al., 2021).

2.9 Turbidity

Light is reflected or absorbed by Solid particles suspended in water, making the water appear "cloudy". These particles consist of suspended inorganic minerals or vegetal that have been brought up above or below the earth. For the fact that the earth functions as an efficient filter, water from deep wells is always clean and turbidity-free. This issue is more frequent with surface water. Turbidity is widely an aesthetic issue, but suspended materials may also reflect infectious contamination. A reasonable number of organic debris can also leave stains on sinks and clothes (WHO 2015).

2.10 Nitrogen

Nitrogen in water and wastewater are of four categories namely ammonia nitrogen, organic nitrogen, nitrite nitrogen, and nitrate nitrogen. Nitrites and nitrates are formed by microbial transformation of a greater percentage of organic nitrogen and ammonia through water contamination by sewage (Akpanusen et. al., 2017). Nitrogen in the form of nitrate is a primary nutrient for plant growth and can also constitute a factor for growth-limiting nutrients.

Elevated nitrate levels in surface water can trigger fast algae growth which potentially reduces the quality of water. Nitrates can be found in groundwater by infiltrating chemical fertilizers used in agricultural farmlands. Too much nitrate amount (greater than 10 mg/l) in drinking water may result in instant and severe health risks to newborns. The nitrate ions react with blood hemoglobin thereby causing a reduction in the ability of blood to carry oxygen resulting in a disease known as blue baby or methemoglobinemia (Biswas and Tortatada 2019).

2.11 Iron (Fe)

The availability of iron (Fe) and manganese (Mn) in large amounts is readily noticeable due to the reddish-brown stain these inorganic mineral deposits cause. This stain is seen on laundry materials, sinks, and every other object contacted by the water. Iron is the fourth most sufficient constituent by weight found on the earth's crust. Natural water may contain different quantities of iron regardless of its widespread sufficiency and distribution. Moreover, iron is present as ferrous (Fe2+) in groundwater and forms a clear colorless solution when it reacts with oxygen and is transformed into the ferric state (Fe3+). This ferric state reacts with alkalinity in water or when exposed to the atmosphere to form an insoluble brown ferric hydroxide precipitate. As a trace element, iron is required by both plants and animals, and it is important for the transport of oxygen in the blood of both vertebrate and some invertebrate animals (Shittu et. al., 2020).

Iron in water varies based on the geology and other chemical properties of the waterpath. Ferrous (Fe2+) and Ferric (Fe3+) ions are basic forms of concern in the aquatic domain. Aside from staining problems, a large concentration of Fe affects the taste of water which could lead to the formation of iron bacteria which are very unpleasant though not a health issue. They form masses of big and filamentous organic matter that traps the iron they need for growth. A good indicator of the iron content in the system is the brownish slimy growth in the toilet flush tank (WHO 2015).

2.12 Nitrate (NO3)

Nitrates (NO3) are not usually adsorbed by soil and so move with water. According to Okereke et. al., 2014, nitrates are mostly available in the water around farmlands or regions where high agricultural fertilization applications. Industrial and Municipal wastewater, septic tanks, and feedlot discharges from car exhausts are other important channels for nitrogen into water bodies. The nitrate concentration in drinking water is very important for infants, due to their high intake of water as regards their body weight. Nitrates in infants are usually converted to nitrites that oxidize blood hemoglobin to methemoglobin. in the body. The blood cells that are altered can no longer transport oxygen to the brain resulting in brain damage or suffocation. Nitrite levels in water more than 1.0 mg/l should not be considered for feeding infants. According to WHO 2015, epidemiological studies demonstrate the relationship between high nitrate levels and gastric/stomach cancers in humans.

2.13 Acidity

Hydrogen Proportion (pH) measures the acidity or alkalinity of a solution. Water with pH ranging from 6.0 to 9.0 protects the life of freshwater such as fish and invertebrates. Most enzymes and proteins have low pH differing much from pH 7.0 which can alter the proper functioning of the organism or may even kill it. Low pH increases and triggers the release of toxic metals from soils and sediments. On the other hand, alkalinity is an important parameter that measures the capability of water to withstand acidity, such as acid rain. The important environmental effect of pH in water is its influence on certain chemical materials to become toxic.

3.0 Materials and Methods

3.1 Study Area: The Unwana Beach River is situated in Unwana in Afikpo North LGA of Ebonyi State as shown in Figure 1 below. The climate in the area is tropical with alternating rainy and dry seasons. The Unwana Beach River lies between latitude $N05^{0}78^{11}33^{1}$ and longitude $E07^{0}93^{11}33^{1}$ an elevation of 107m above sea level. It is located in the south of Ebonyi State, bounded by Afikpo in the north, Edda in the west, and Cross River State in the east. The river width is more than 100m and the banks of the river in this area are prone to constant erosion. The population of the inhabited community of Afikpo is estimated at 120,000 (Nigeria Census 2006). The area consists of an open grassland and tropical forest with average annual rainfall of 198cm. The River is used by the communities for multiple activities including agriculture, laundry, drinking, fishing, commercial purposes (collection of fine sand for sale, transportation of goods through canoe), car washing, bathing, watering of crops, and at some certain areas swimming by youths.

Therefore, the evaluation of the quality of Unwana River water for potability is a major health concern in the Unwana community.

3.2 Water samples collection

Eight (8) water samples were collected from different locations of Unwana Beach River where the villagers do their laundry, sand dredging, fishing, and other recreational activities (samples at CP5 to CP8 downstream) and upstream (samples at CP1 to CP4) where they draw water for home uses.

The water samples were collected in clean sterilized bottles with stoppers. Clinical hand gloves were used to avoid contaminating the samples collected. The samples were taken to the laboratories immediately after collection for analysis.

The bacteriological tests were conducted in the microbiology laboratory and the physiochemical tests were conducted in the water resources laboratory of Akanu Ibiam Federal Polytechnic Unwana, Ebonyi state.

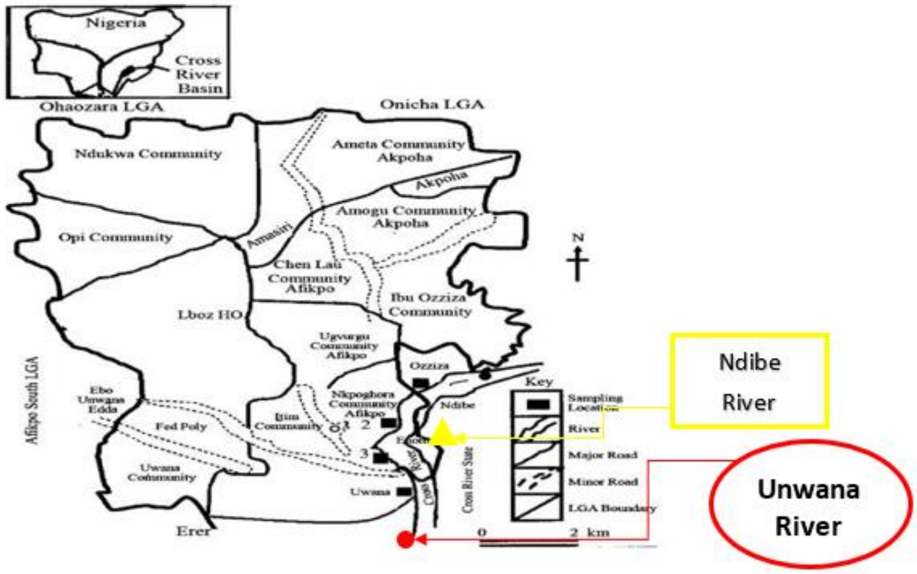

Figure 1: Map showing Unwana Beach River (National Geographic, 2025)

3.3 Analysis of physicochemical parameters

1. Total Dissolved Solids (TDS) and Total Suspended Solids (TSS): A filtered water sample quantity of 100 ml was oven-dried in a beaker. The difference in the weight of the empty beaker and the oven dried content was used to estimate the TDS. 100 ml of the water sample was selected. The selected volume of sample was poured into the filtration apparatus and allowed through filter into the filter flask. The measuring cylinder was rinsed into the filtration apparatus with three successive 10 ml portions of distilled water and allowing complete drainage between each rinsing. The filter was dried in an oven at 105^0C. The filter was taken out of the oven and cooled in a desiccator to room temperature, weighed and the TSS was estimated.

2. Turbidity: This was done using the Digital turbidity meter calibrated with distilled water. The digital turbidity meter was switched on and allowed to warm up. The required turbidity range was selected for measurement and the display was adjusted to 000 by adjusting the Set Zero Knob. The test tube containing distilled water was removed and another test tube was filled with a standard solution of 400 NTU as per the expected turbidity range of the unknown solution and placed in the test tube holder. The measurement of the solution suspension was taken, and the calibrated knob was adjusted so that the display read the selected standard solution value. The display zero was checked with the test tube containing distilled water. The test water samples in the various test tubes were in turns placed in the test tube holder, closed and the measurement of the turbidity value of each test water sample was read and recorded.

3. **Ammonium, Nitrate, Phosphate, and Nitrite:** The water samples were analyzed for these chemical contents using the "AQUANAL Fishwater Lab" water testing kit. In this method, appropriate volumes of the samples of water in the specified test tubes were tested using the designed reagents for the chemical parameter by adding the reagents to the standard prescribed number of drops. The samples were shaken and allowed to stand for a maximum period of 10 minutes and matched to a color ng the medium on the chart corresponds to the concentration of the chemical parameter measured in mg/l.

3.4 Analysis of Bacteriological Parameters

The reagents used for the bacteriological test were Nutrient agar, mac conkey agar, salmonella shigella agar, sucrose, lactose, glucose, normal saline, peptone water, and ringer solution. Each of the agar was prepared according to the manufacturer's guide. 1 ml of each of the samples was taken and put into the 9 ml of distilled water. The dissolved mac conkey agar, salmonella shigella agar, and nutrient agar were distributed in ten different petri dishes. 0.1ml from selected dilutions was incubated in petri dishes. The media for isolation were poured using a pour plate into each plate and incubated for 24 hours at 37°C. The solid culture media such as nutrient agar, salmonella agar, and Mac Conkey agar used for the isolation and recording of the microorganisms present in the water sample were sterilized in the autoclave for 15 minutes at a temperature of 121°C. In the first tube, 9 ml of the sample was added to all five tubes. 1 ml of each sample was added to tube 1, mixed, and stirred to tube 2, up to the last tube being the fifth tube. 1 ml of each dilution was distributed into a sterile glass petric dish using a fresh sterile pipette for each dilution. The sterile motten Mac Conkey agar, salmonella shigella agar, and nutrient agar were aseptically poured into a peltry dish containing the samples. These were well mixed by swirling the plate gently and then allowed on the bench to set. The plates were incubated at 37°C for 24 hours after solidification. The tubes with higher dilution and the lowest concentration that showed visible growth (1 – 300) were counted and the number of colonies was recorded.

Cultural morphology: The size, shape, pigmentation, and marginal and elevation characteristics of the different species of bacteria were examined in Mac Conkey agar, nutrients agar, and salmonella shigella agar plates after an appropriate incubation period. The isolated colonies were identified based on their cultural morphology on the three agar plates. The identified colonies were subcultured onto a Peptone water bottle and fresh mac conkey agar, nutrient agar, and salmonella shigella agar in a fresh agar plate for further identification. There inoculated bottle and agar plates for each colony were incubated at 37°C for 24 hours. The pure cultures were gram-stained each with gram reagents. The pure cultures were further inoculated into citrate agar slate, carbohydrate sugar, and a water bottle containing 1% of each to help identify the isolated to a specific level. Those media were inoculated for 24 hours at 37°C. The organisms isolated from the sample include the following: E.coli, staphylococcus, shigella, and salmonella.

4.0 Physiochemical and Bacteriological Tests Results: The physiochemical contents that were assessed in water samples are presented in Table 1 below.

Table 1: Physiochemical and bacteriological properties tests results of water samples

Water Quality Parameter	Sample Collection Point (CP) CP1	CP2	CP3	CP4	CP5	CP6	CP7	CP8	Mean Value	NSDWQ (2017) (mg/l)	WHO (2015) (mg/l)
TDS (mg/l)	320	368	393	452	508	506	440	412	424.75	500	600 - 1000
TSS (mg/l)	50	42	68	110	132	116	98	62	84.75	NS	30
Turbidity (NTU)	7.0	8.0	8.0	12.0	15.0	15.0	12.0	10.0	10.88	5.0 NTU	5.0 NTU
CO_3 (mg/l)	214	214	250	268	412	428	375	321	310.25	500	500
Fe (mg/l)	0.2	0.2	0.3	0.42	0.6	0.6	0.45	0.3	0.38	0.2	0.2
NO_3 (mg/l)	10.0	10.0	12.5	17.5	25.0	25.0	25.0	17.5	17.8	50	45
NO_2 (mg/l)	0.08	0.08	0.15	0.2	0.3	0.3	0.2	0.15	0.18	0.2	3.0
pH	7.5	7.6	7.5	7.5	7.2	7.8	7.5	8.0	7.58	6.5 – 8.5	6.5 – 8.4
E.coli (cfu/ml)	2	3	2	4	5	5	3	2	3.25	0	0
Microbial Count/TCC (cfu/ml)	5	5	4	6	9	8	6	5	6.0	10	3

Source: Uchendu Emeka Ndukwe (2024)

4.1 Discussion of Physiochemical Results: The results in Table 1 above showed that the mean concentrations of Total Dissolved Solids (TDS), Carbonate Hardness, Nitrate, Nitrite, and pH in water sampled from eight (8) different locations in Unwana River were 424.75 mg/l, 310.25 mg/l, 17.8 mg/l, 0.18 mg/l and 7.58 respectively which were within the maximum allowable limit set by (NSDWQ 2017) and (WHO 2015) while the concentrations of Total Suspended Solids (TSS), Turbidity and Iron were 84.75 mg/l, 10.88 NTU and 0.38 mg/l respectively and were slightly above the maximum allowable limit set by NSDWQ (2017) and WHO (2015). These results were in close comparison with what was submitted (13.2 mg/l, 0.12 mg/l, and 7.5 for nitrate, nitrite, and pH respectively) by Ibiam et. al., 2023, which were carried out on an adjoining stream to Unwana River.

Nitrate and Nitrite are very important nutrients for many plants and at times play roles such as growth-limiting nutrients. They are also used by algae and other water plants to form protein which subsequently are used by animals to form aquatic animal protein. The pH value in the river is important because it determines the survival and sustainability of aquatic animals and plants (a pH below 4 or above 10 can adversely impact most aquatic animals and plants). Most heavy metals like lead and chromium are more readily dissolvable in low pH water (high acidic water) and may become much more toxic in water causing harm to the aquatic.

The awareness of the TDS and TSS is helpful in the operation of water treatment plants because they averagely result in the volume of organic substance present in concentrations of total solids of the river water and industrial wastewater. The carbonate hardness in the water could be caused by the presence of dissolved minerals in water which causes temporary hardness which manifests as difficulty in forming lather with soap and scale deposits in hot water pipes.

4.3 Graphical presentation of variation of physiochemical parameter results

The variation of the Total Dissolved Solids (TDS) and Total Suspended Solids (TSS) concerning the water samples collection points is presented in Figure 2 below.

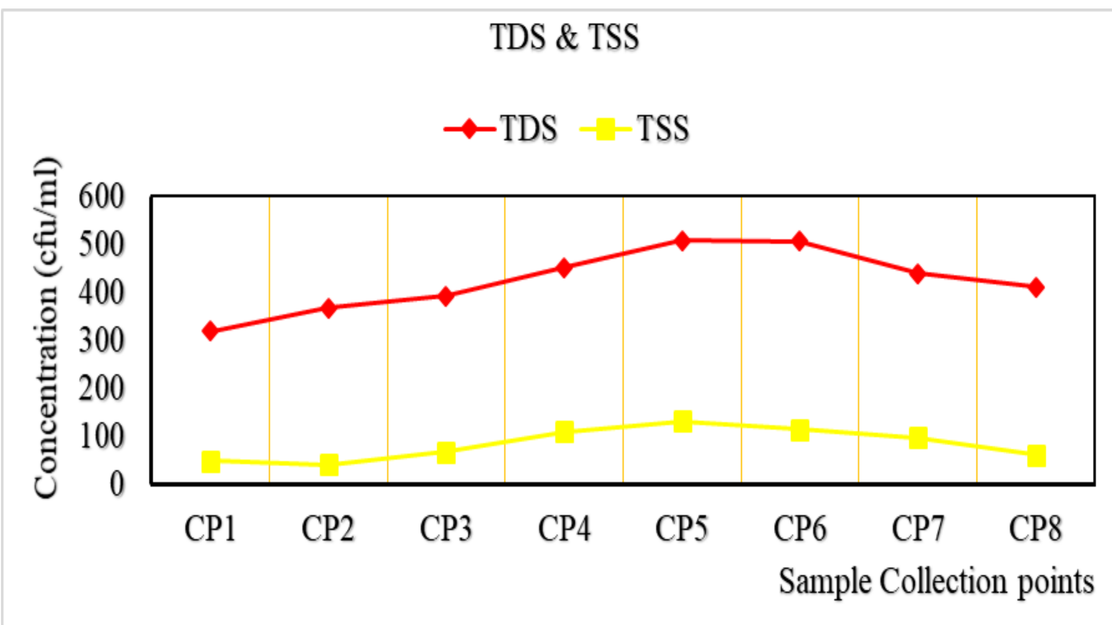

Figure 2: Variation of TDS and TSS in water samples Source: Uchendu Emeka Ndukwe **(2024)**

The graph in Figure 2 above showed a visibly wide variance in TDS and TSS in the water samples for the different sampling locations.

4.4 Graphical presentation of variation of bacteriological parameter results

The variation of the E.coli and microbial count concerning the water sample collection points is presented in Figure 3 below.

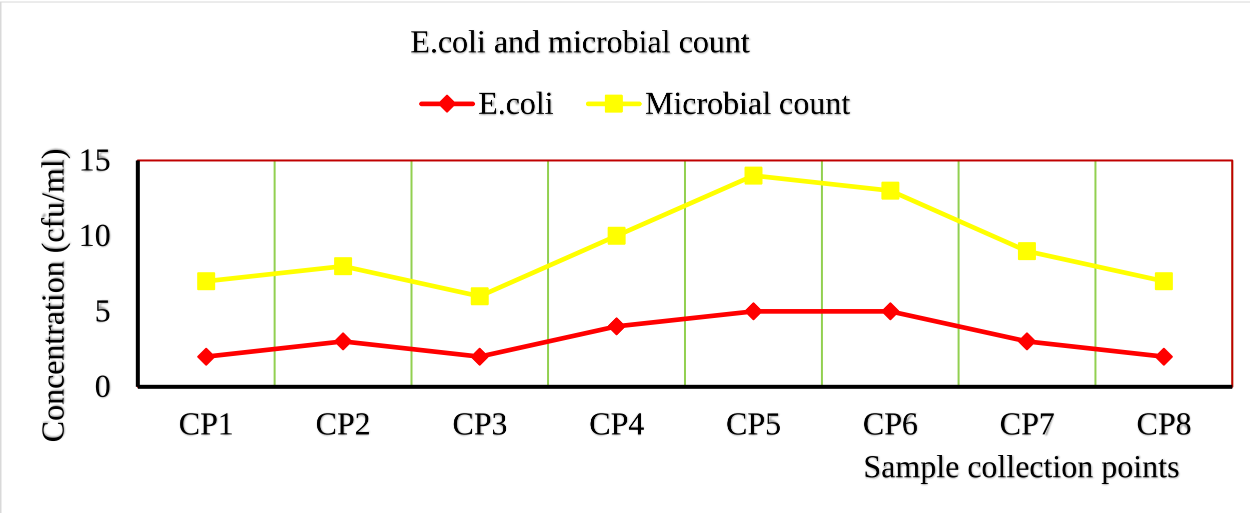

Figure 3: Variation of E.coli and Microbial counts in water samples

Source: Uchendu Emeka Ndukwe **(2024)**

The graph in Figure 3 above showed a slight variation in E.coli and microbial count in the water samples for the different sampling locations.

5.0 Conclusion

From the findings, the eight (8) different water sampling locations contained different levels of concentration for total dissolved solids, total suspended solids turbidity carbonate hardness, iron, nitrate, nitrite, and pH levels and it was found out that the total suspended solids, turbidity, and iron were above the (WHO 2015) and (NSDWQ 2017) standards. Therefore, water from those locations needs proper and adequate screening and treatment before use or consumption to avoid intoxication of the prevailing contaminants in the water. It was also found out that Unwana Beach River, being the major water course receiving discharges from other minor streams around the Unwana community, then surface runoff inflows into the river during storm rainfalls which may be carrying human and/or animal excreta might have been the attribute to the microbial and physiochemical contamination of Unwana Beach River.

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