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Bacteriological and Physicochemical Analysis of River Mayo-Gwoi Jalingo, Taraba State.

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ABSTRACT

River Mayo-gwoi is located in Jalingo Taraba State and serves as a major source of drinking water in Jalingo. This research was to assess the bacteriological and physicochemical quality of river Mayo-gwoi. Sixty water samples were collected from three different points along the river and were analyzed in the laboratory using the following method; pour plate and colilert-18 reagent methods. Colilert-18 reagent method employs the use of nutrient indicators to detect *E. coli* and coliforms. These indicators are Ortho-Nitrophenyl-B-Galactoside (ONPG) for total or fecal coliforms, and Methylumbelliferyl-B-D-Glucuronide (MUG) for *Escherichia coli (E. coli)*. Colilert-18 can detect these bacteria at 1cfu/100 mL within 18 hours. The physicochemical parameters that were analyzed are; temperature, electrical conductivity, total dissolved solid, turbidity, pH, alkalinity, chromium, and nitrate. Heterotrophic counts mean values ranges from 9.0 $\times 10^1$to 12.9 $\times 10^1$ (cfu/ml). Coliform counts mean values ranged from 64.6 $\times 10^1$ to 93.7 $\times 10^1$ (cfu/100ml), *E. coli* count mean values ranges from 15.7 $\times 10^1$ to 30.9$\times 10^1$ (cfu/100ml), *Salmonella* count mean values ranges from 4.5 $\times 10^1$ to 11.7 $\times 10^1$ (cfu/ml), and *Shigella* count mean values ranges from 2.9 $\times 10^1$ to 7.9 $\times 10^1$ (cfu/ml). Twenty-five (25) isolates belonging to three bacterial species were identified in the water. They include *Staphlococcus aureus* (52%), *Bacilus spp*. (32%), and *Proteus spp*. (16%). Under physicochemical parameters, temperature mean values range from 27.40 to 27.50^{o}C, electrical conductivity mean values ranges from 153.00 to 193.00, total dissolved solid mean values range from 100.00 to 139.00mg/L, turbidity mean values ranges from 57.00 to 75.00NTU, pH mean values ranges from 6.80 to 7.09mg/L, alkalinity mean values ranges from 27.00 to 34.30mg/L, chromium mean values ranges from 0.09 to 0.18mg/L, and nitrate mean values ranges from 0.10 to 0.50mg/L. From the results gotten from this research work, it can be deduced that the water in river Mayo-gwoi is polluted with coliform and *E. coli*. Therefore, the water in river Mayo-gwoi is unsafe for drinking because most of the parameters such as *Salmonella* count, *Shigella* count, *E. coli*, coliform count, total heterotrophic count, turbidity, and chromium were above the WHO/NSDWQ standard.

Key words: Bacteriological, Physicochemical, Analysis, Jalingo, River, Coliform

Introduction

Water is essential to life, and a satisfactory (adequate, safe and accessible) supply must be available to all [16]. One of the most abundant and readily available sources of fresh water to man is river. Rivers are vital and vulnerable freshwater systems that are critical for the sustenance of all lives. However, the declining quality of the water in these systems threatens their sustainability and is therefore a cause for concern. Rivers are waterways of strategic importance across the world, providing main water resources for domestic, industrial and agricultural purposes [5]. It is the most important freshwater source for man. Unfortunately, river waters are polluted by indiscriminate disposal of sewage, untreated industrial waste and plethora of human activities, which affect their physicochemical characteristics and microbiological qualities [7]. Owing to the large quantity of effluents discharged into receiving rivers, the natural processes of pathogen reduction are inadequate for protection of public health. In addition, industrial wastes that alter the river water pH and provide excessive bacterial nutrients often compromise the ability of natural processes to inactivate and destroy pathogens [5].

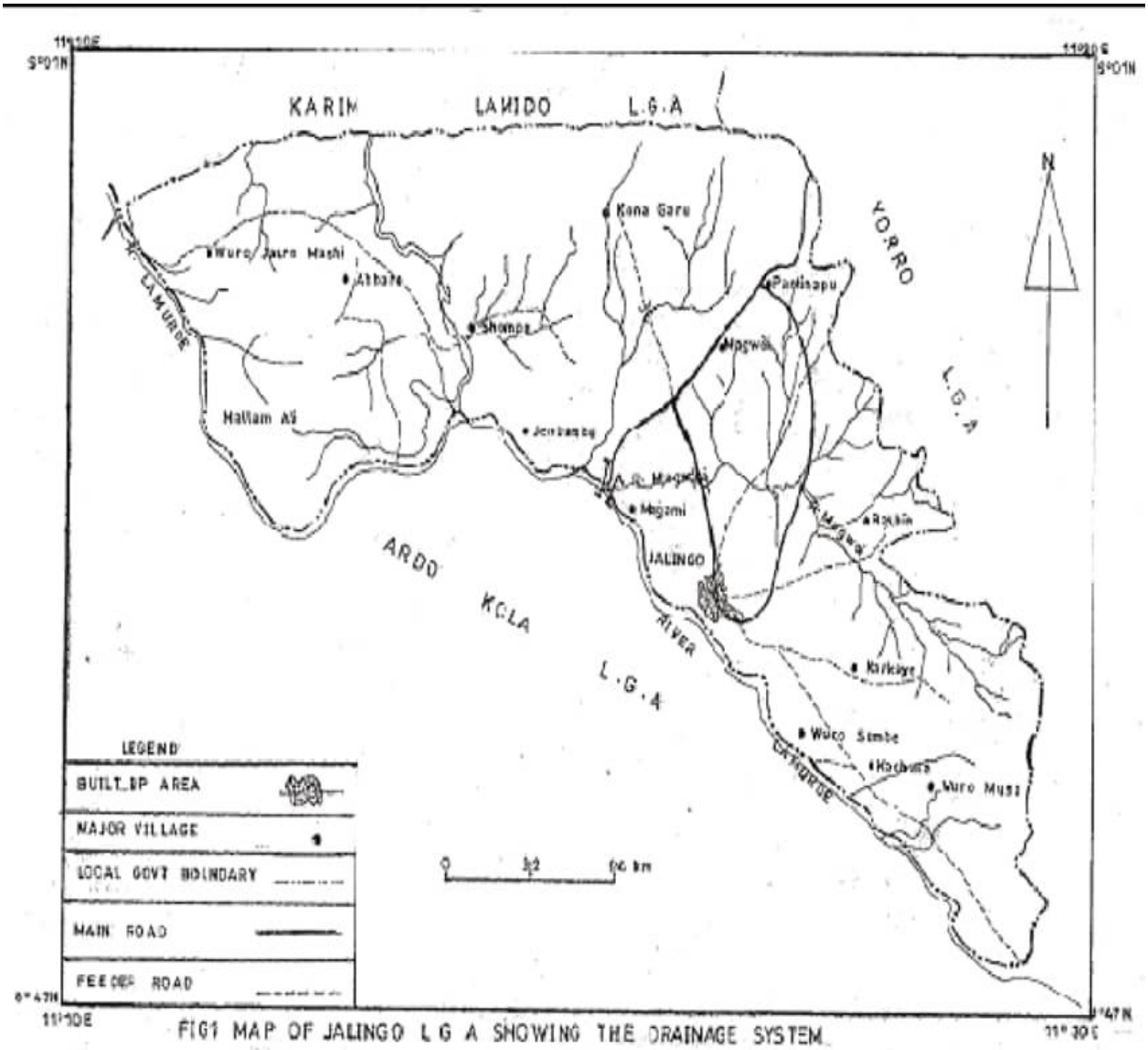
The maintenance of healthy aquatic ecosystem is depended on the physicochemical properties and biological diversity. A regular monitoring of water bodies would not only prevent the outbreak of diseases and occurrence of hazards but would check the water from further deterioration. Bacteriological assessment particularly for coliforms, the indicators of contamination by fecal matters is therefore routinely carried out to ascertain the quality and potability of water to ensure prevention of further dissemination of pathogens. The *use* of indicator bacteria such as fecal coliforms and fecal streptococci for assessment of fecal pollution and possible water quality deterioration in fresh water sources is generally recommended [2]. Pathogens

are a serious concern for managers of water resources, because excessive amounts of fecal bacteria in sewage and urban run-offs have been known to indicate risk of pathogen-induced illnesses in humans. The aim of this study was to assess the bacteriological and physicochemical characteristics of river mayo gwoi Jalingo, Taraba state.

Materials and Method

Study Area

The study will be carried out on river Mayo-gwoi located in Jalingo, Taraba state. The city of Jalingo (Centre of Muri Emirate) is located between latitude 8°47' to 9°01'N and longitude 11°09' to 11°30'E. It is bounded to the north by Lau Local Government Area (LGA), to the East by Yorro L.G.A, to the south and west by Ardo-Kola LGA. It has a total land area of about 195.071 km^2. Jalingo L.G.A has a population of 139,845 people according to the 2006 population census, with a projected growth rate of 3% [10] [14]. The mayo-gwoi river is one of the main rivers in Jalingo which originated at Lamurde river which is a subsidiary of Cameroonian river, flows northwest to southeast at a 745km. The river is the source for an extensive irrigation system and domestic usage. Downstream stretch of river Mayo-gwoi is located in Jalingo district of Taraba state (figure 3.1).



Source: [14]

Figure 3.1: Map of Jalingo

Sample Collection

Sixty samples were collected from the river, the river was divided into three i.e. the upper, middle, and lower course, twenty samples were collected from each of the course. The samples were collected in a sterile bottle, labelled for easy identification and was transported in cooler containing icepack to Taraba state water and sewerage corporation central laboratory for analysis.

Bacteriological Analysis

Standard method of colilert-18 reagent: Colilert-18 either simultaneously detects total coliforms and *E. coli*; or fecal coliforms in water. It is based on IDEXX's proprietary Defined Substrate Technology. The reagent makes use of nutrient indicators to detect *E. coli* and coliforms. These indicators are Ortho-Nitrophenyl-B-Galactoside (ONPG) for total or fecal coliforms, and Methylumbelliferyl-B-D-Glucuronide (MUG) for *E. coli*. When E. coli metabolize Colilert-18's DST nutrient-indicator, the sample also fluoresces when observed under the ultra-violet light. Colilert-18 can simultaneously detect these bacteria at 1 cfu/100mL within 18 hours even with as many as 2 million heterotrophic bacteria per 100 mL present.

Colilert-18 reagent procedures

Presence/absence (p/a) procedure: One pack of the reagent was added to the sample (100ml) in a sterile, transparent, non-fluorescing vessel. The vessel was capped and shook gently. The sample was incubated at 35±0.5°C for 18 hours. The result was read using the result interpretation table.

Quanti-tray enumeration procedure: One pack of the reagent was added to the sample (100ml) in a sterile vessel at room temperature, the vessel was capped and shake gently until it dissolves. The sample/reagent mixture was transferred into a Quanti-Tray or Quanti-Tray/2000 and sealed in an IDEXX Quanti-Tray Sealer. The sealed tray was incubated at 35±0.5°C (or 44.5±0.2°C for fecal coliforms) for 18 hours (pre-warming to 35°C is not required). The quati-tray was observed under a U.V light and the result was read using the result interpretation table. The number of positive wells were counted and referred to the Most Probable Number (MPN) table provided with the trays to obtain the MPN.

Serial dilution: is a series of sequential dilutions that are performed to convert a dense solution into a more usable concentration. For a ten-fold dilution, 1 ml of sample is added to 9 ml of diluent. The sample/culture was taken in a test tube, with 9 ml of sterile diluents, which can either be distilled water or 0.9% saline, were taken. A sterile pipette was used to take 1 ml of the properly mixed sample/culture. The sample was added to the test tube to make the total volume of 10 ml. This will provide an initial dilution of 10^{-1}. The dilution was thoroughly mixed by emptying and filling the pipette several times. The pipette tip was discarded, and a new pipette tip was attached to the pipette.

Preparation of *Salmonella Shigella* agar: The media was prepared according to the manufacturer's instruction (60.0 grams in 1000ml distilled water).

Preparation of nutrient agar: The media was prepared according to the manufacturer's instruction (28 g in 1000ml of distilled water). The mixture was heated in other to dissolve completely and autoclaved at 121^{O}C for 15 minutes.

Procedures for inoculation: The petri dish was labelled properly. The sample was obtained using dilution series between 0.1ml and 1.0ml. A micropipette was used to dispense 1ml of the sample into the petri dish. The media was added to the sample aseptically and it was mixed gently. The media was allowed to solidify and it was incubated at 37^{0}C for 24 hours.

Physicochemical Analysis

Determination of pH: The meter was switched on and the container was filled with a standard solution. The sensor module was washed with water and wiped with a tissue. The sensor module was placed in the container containing the standard solution and it was stirred three times. When the pH was stabilized and the calibration was display, the sensor module was removed, washed, and wiped with tissue. The same procedure was repeated in another container. The reading was taken and written in one decimal place.

Determination of conductivity/ total dissolved solid (TDS): The Wagtech H198311 water proof EC/TDS meter was calibrated in accordance with the manufacture's instruction manual using Wagtech H17031 calibration solution (14413 µS/cm), [2]. The electrode of the meter was rinsed with distilled water and allowed to dry, it was then dipped into the water sample, and the sample was stirred gently to create a homogeneous sample. The conductivity was allowed to stabilize before taking the reading.

Determination of nitrate: Nitrate was selected from the stored program in the spectrophotometer. The tube (0290) was rinsed using 10ml of the sample water. The tube was inserted into the chamber, the lid was closed, and scan blank option was selected. The tube was removed and nitrate spectrophotometric tablet was added and shake vigorously. The tube was inserted into the chamber after 5 minutes and the sample was scanned. The result will be recorded in ppm.

Determination of chromium: The test was selected on the spectrophotometer. One chromaver reagent powder pillow was added to the sample cell and it was swirled to mix. The instrument timer was on and 10ml of the sample was added to the sample cell. The blank was inserted into the cell holder and the spectro was zeroed when the timer expires. The prepared sample was inserted into the cell holder and the result was read.

Determination of alkalinity: All program tests were selected on the spectrophotometer. Alkalinity Unit Dose Vial (UDV) test was selected from the program list. The cuvette (0156) was rinsed with the sample water**.** 3ml of the sample was added to the cuvette, the cuvette was inserted into the

chamber and scanned blank. The cuvette was removed from the spectrophotometer, 3ml of the sample was added to the cuvette (4318). The cuvette was inverted 3 times after 2 minutes. The tube was inserted in the chamber and the sample was scanned. The result was read and recorded.

Determination of temperature: The thermometer was immersed into the sample water until the liquid column in the thermometer stops moving (approximately 1 minute, or longer if necessary). The result was read and recorded to the nearest 0.1°C.

Biochemical Test

Sugar fermentation test: This test was carried out to investigate the ability of the isolates to ferment various sugars. The medium used consisted of peptone water as basal medium and 1 % appropriate sugar with suitable indicator (Phenol Red). Five (5ml) of solution was dispensed into test tubes. Sterile Durham tubes were inserted into each of the medium in a test tube and sterilized at 121^{o}C for 15minutes. Acid production was shown by a change in a color of the medium from red to yellow, while gas production was indicated by the displacement of the solution in the Durham tube by air (carbon-dioxide). The various sugars used were glucose, lactose sucrose and mannitol [3].

Urease reaction test: The urease test was done to detect the production urease enzyme needed for breakdown of urea into ammonia and carbon – dioxide. Urea agar base medium was used for this test and prepared according to the manufacturer's specification. Five (5ml) was dispensed into test tubes and were sterilized by autoclaving at 121^{o}C for 15 minutes. The isolate was stabbed and streaked on the medium in each bottle and incubated at 30^{o}C for 24hours. Uninoculated medium served as control. After the period of incubation, the bottles were checked for color change. Change in color of the medium from orange to pink indicated positive result while negative result is indicated by creamy to yellowish [3]**.**

Hydrogen sulfide test: Sulfite Indole Motility (SIM) agar medium was used for this test and prepared according to the manufacturer's specification and 5ml was dispensed into test- tubes. Test tubes were sterilized by autoclaving at 121^{o}C for 15 minutes and allowed to set in semi – solid (paste) form. The fresh culture of each isolate was stab inoculated into medium in each test tube and incubated at 37^{o}C for 24 hours. After the period of incubation, each inoculated isolate was checked for production of hydrogen sulphide gas (H_2S). Positive result was indicated by black coloration at the base of the test tube while absence of black coloration indicates negative result [4].

Indole test: Sulfite Indole Motility (SIM) agar medium was used for this test and prepared according to the manufacturer's specification and 5ml each was dispensed into test- tubes. Test tubes were sterilized by autoclaving at 121^{o}C for 15 minutes and allowed to set in semi – solid (paste) form. The fresh culture of each isolate was inoculated into medium in each test tube and incubated at 37^{o}C for 24 hours. After the period of incubation, 3-4 drops of Kovac's reagent were then added to the culture. If a pinkish red color in ring form develops on the surface of the medium, this indicates a positive reaction while no change in color indicates a negative reaction [4].

Motility test: Sulfite Indole Motility (SIM) agar medium was used for this test and prepared according to the manufacturer's specification and 5ml each dispensed into test- tubes. Test tubes were sterilized by autoclaving at 121^{o}C for 15 minutes and allowed to set in semi – solid (paste) form. Each of the tubes was stab-inoculated to about half the depth of the medium. The tubes were incubated for 24 hours and examined for diffuse growth from the line of streak, which is index for motility [4].

Methyl red test: The methyl red test was done to detect the production of acid during the fermentation of glucose and maintenance of acidic condition. Methyl Red – Voges Proskauer medium (Glucose phosphate broth) was used for this test and prepared according to the manufacturer's specification. Five (5ml) of the media was dispensed into screw capped tubes and sterilized at 121^{o}C for 15 minutes. The glucose phosphate broth was inoculated with fresh culture of each bacterial isolate and incubated at 37^{o}C for 24 hours. an uninoculated medium served as control. After the period of incubation, 2-3 drops of methyl red reagent were added. Red coloration indicated positive result (i.e. acid production) while yellow coloration indicated negative reaction [3].

Catalase test: This was done using the grease free slide method. A drop of 3% hydrogen peroxide solution was poured on a sterile grease free slide. Using a sterile wire loop, a colony of the test organism was immersed in the 3% hydrogen peroxide solution. The test was observed immediately for bubbling. A test with active bubbling shows positive catalase test indicating the presence of Staphylococcus species while absence of bubbles shows negative catalase test indicating the presence of streptococcus species [4].

Coagulase test: this was done using serum on a grease free slide. A drop of the serum was placed on the slide and a loop of the isolate was added to it. The mixture was emulsified and rocked gently in other to check for agglutination. Positive results show agglutination while negative result does not show agglutination [4].

Statistical Analysis

The data will be subjected to analysis using Special Package for Social Sciences (SPSS), version 25. The results will be presented as mean ± standard deviations using Analysis of Variance (ANOVA) with mean separated by Duncan. Differences between the experimental mean and WHO/NSDWQ standard values was considered to be significant at $p<0.05$.

Results and Discussion

Table 4.1: presents the bacteriological analysis of river Mayo-gwoi. It shows the mean values for the total heterotrophic count (the lower course has the highest values of 12.87×10^1 while the upper course has the lowest values of 9.01×10^1), *Salmonella* count (the lower course has the highest values of 11.68×10^1 while the upper course has the lowest values of 4.52×10^1) , *Shigella* count (the lower course has the highest values of 7.89×10^1 while the upper course has the lowest values of 2.14×10^1) , coliform count (the middle course has the highest values of 93.72×10^1 while the lower course has the lowest values of 64.62×10^1), and *Escherichia coli* count (the upper course has the highest values of 30.93×10^1 while the lower course has the lowest values of 15.71×10^1), at the upper, middle, and lower course.

Table 4.1: Bacteriological Analysis of Water Samples

Sample	Total Heterotrophic count (cfu/ml) $x10^1$	*Salmonella* count (cfu/ml) $x10^1$	*Shigella* count (cfu/ml) $x10^1$	Coliform count (cfu/100ml) $x10^1$	*Escherichia coli* Count (cfu/100ml) $x10^1$
UCW	9.01 ± 2.63^b	4.52 ± 2.36^c	2.14 ± 0.83^b	89.49 ± 19.15^a	30.93 ± 20.11^a
MCW	$9.89\pm3.06a^b$	7.12 ± 2.86^b	3.51 ± 1.62^b	93.72 ± 15.58^a	25.09 ± 18.95^a
LCW	12.87 ± 4.10^a	11.68 ± 5.24^a	7.97 ± 3.15^a	64.62 ± 34.24^b	15.71 ± 10.26^b
WHO	0	0	0	0	0
NSDWQ	0	0	0	10	0

Values are presented as mean ± SD and values with different superscript within the same column are significantly different ($p<0.05$).

KEY:

UCW- Upper Course Water

MCW- Middle Course Water

LCW- Lower Course Water

WHO- World Health Organization

NSDWQ- National Standard for Drinking Water Quality

Table 4.2: shows the physicochemical analysis of river mayo-gwoi. The table contains the mean values for temperature (the upper course has the highest values of 27.5^{0C} while the middle course has the lowest values of 27.42^{0C}), turbidity (the lower course has the highest values of 75.07 NTU while the upper course has the lowest values of 57.77NTU), electrical conductivity (the upper course has the highest values of 193.41 while the lower course has the lowest values of 153.70), total dissolved solid(the upper course has the highest values of 139.95mg/L while the lower course has the lowest values of 100.70mg/L), pH (the lower course has the highest values of 7.09 while the upper course has the lowest values of 6.82), alkalinity(the middle course has the highest values of 34.29mg/L while the upper course has the lowest values of 27.18mg/L), nitrate (the upper course has the highest values of 0.46/mgL while the middle course has the lowest values of 0.10mg/L), and chromium(the upper course has the highest values of 0.18mg/L while the middle course has the lowest values of 0.09mg/L), at the upper, middle, and lower course.

Table 4.3: this shows the summarized biochemical characterization of isolates.

Figure 4.1 shows the mean values for heterotrophic count at the upper, middle, and lower course. The lower course has the highest values while the upper course has the lowest values.

Figure 4.2 indicates the mean values of *Salmonella* count at the upper, middle, and lower course. The lower course has the highest values while the upper course has the highest values.

Figure 4.3: this represents the mean values of *Shigella* count at the upper, middle, and lower course. The lower course has the highest values while the upper course has the lowest values.

Figure 4.4: this represents the mean values of coliform count at the upper, middle, and lower course. The upper course has the highest values while the lower course has the lowest values

Table 4.2 Physicochemical Analysis of Water Samples

Samples	Temperature (°C)	Turbidity (NTU)	Electrical conductivity	Total Dissolved Solid (mg/L)	pH	Alkalinity (mg/L)	Nitrate (mg/L)	Chromium (mg/L)
UCW	27.56±0.37^{a}	57.77±28.91^{b}	193.41±34.84^{a}	139.95±29.20^{a}	6.82±0.12^{a}	27.18±9.49^{bc}	0.46±0.74^{a}	0.18±0.12^{a}
MCW	27.42±0.30^{a}	64.90±23.26^{a}	166.44±22.22^{b}	104.00±18.01^{b}	6.95±0.24^{a}	34.29±4.38^{a}	0.10±0.21^{b}	0.09±0.06^{bc}
LCW	27.51±0.58^{a}	75.07±16.74^{a}	153.70±38.04^{b}	100.70±23.01^{b}	7.09±0.40^{a}	32.58±9.61^{ab}	0.14±0.07^{b}	0.11±0.10^{ab}
WHO	30	5-25	1000	500-1000	6.5-8.5	20-200	50	0.05
NSDWQ	30	5	1000	500	6.5-8.5	20-200	50	0.05

Values are presented as mean ± SD and values with different superscript within the same column are significantly different ($p<0.05$).

KEY:

UCW- Upper Course Water

MCW- Middle Course Water

LCW- Lower Course Water

WHO- World Health Organization

NSDWQ- National Standard for Drinking Water Quality

Table 4.3: Summarized Biochemical Characterization of Isolates

Gram staining	Shape	H_2S	Indole	Motility	Gas Production	Methly Red	Voges Proskeur	Urease	Catalase	Coagulase	Glucose	Sucrose	Lactose	Mannitol	Probable organisms
+	Rod	-	-	-	-	-	-	+	+	ND	A	-	-	A	*Bacillus spp.*
-	Rod	-	-	+	-	-	-	+	+	ND	A	A	-	-	*Proteus spp.*
+	Cocci	ND	ND	ND	ND	ND	ND	+	+	+	A	A	A	A	*Staphylococcus aureus*

KEY:

ND- Note Done

A-Acid production

(+) - Positive

(-) - Negative

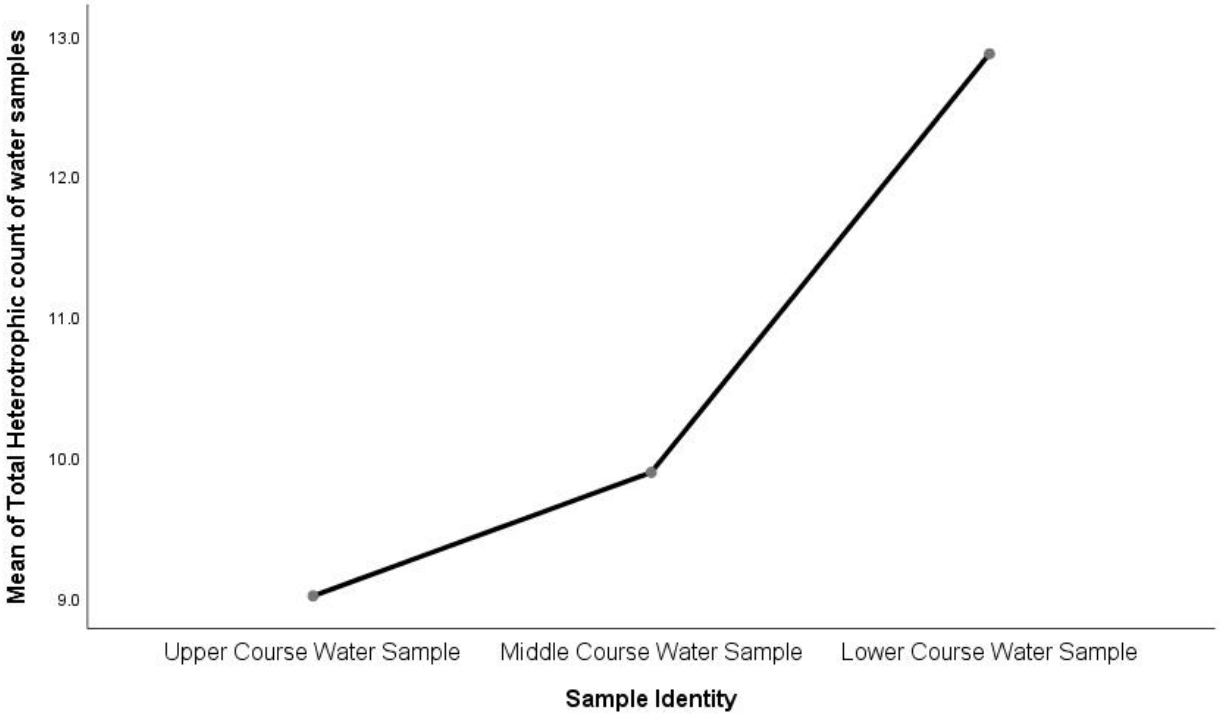


Figure 4.1: Mean Heterotrophic Count

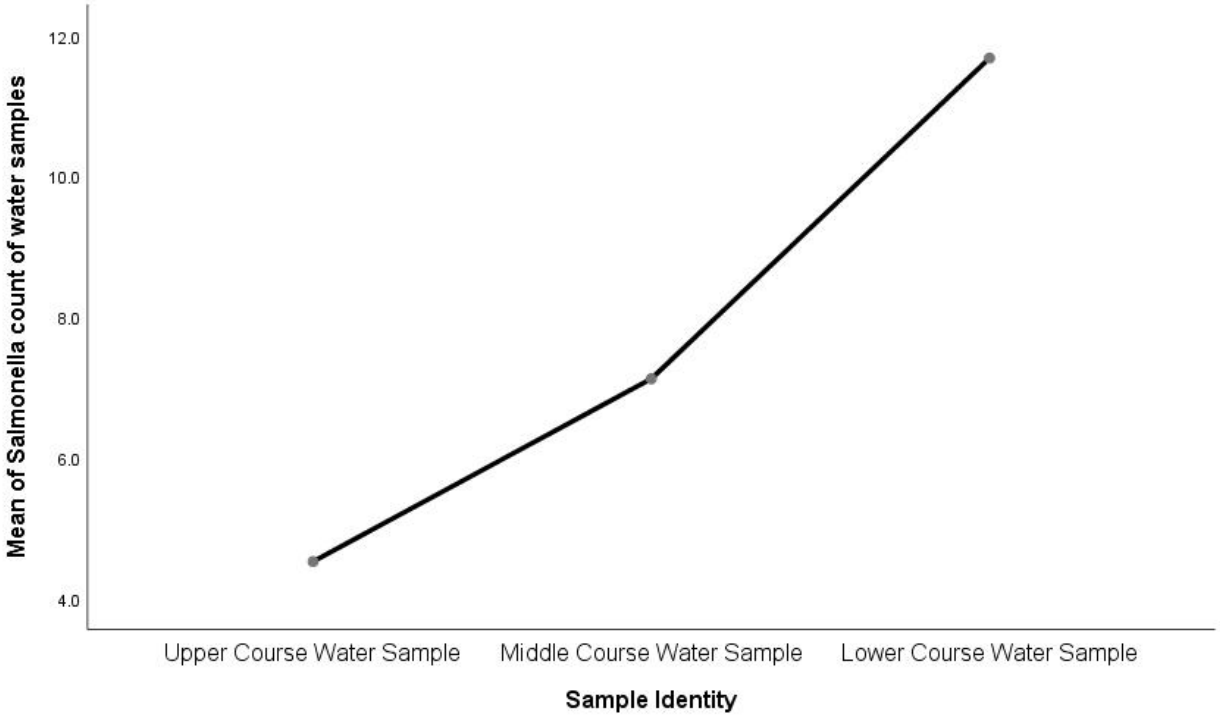


Figure 4.2: Mean *Salmonella* count

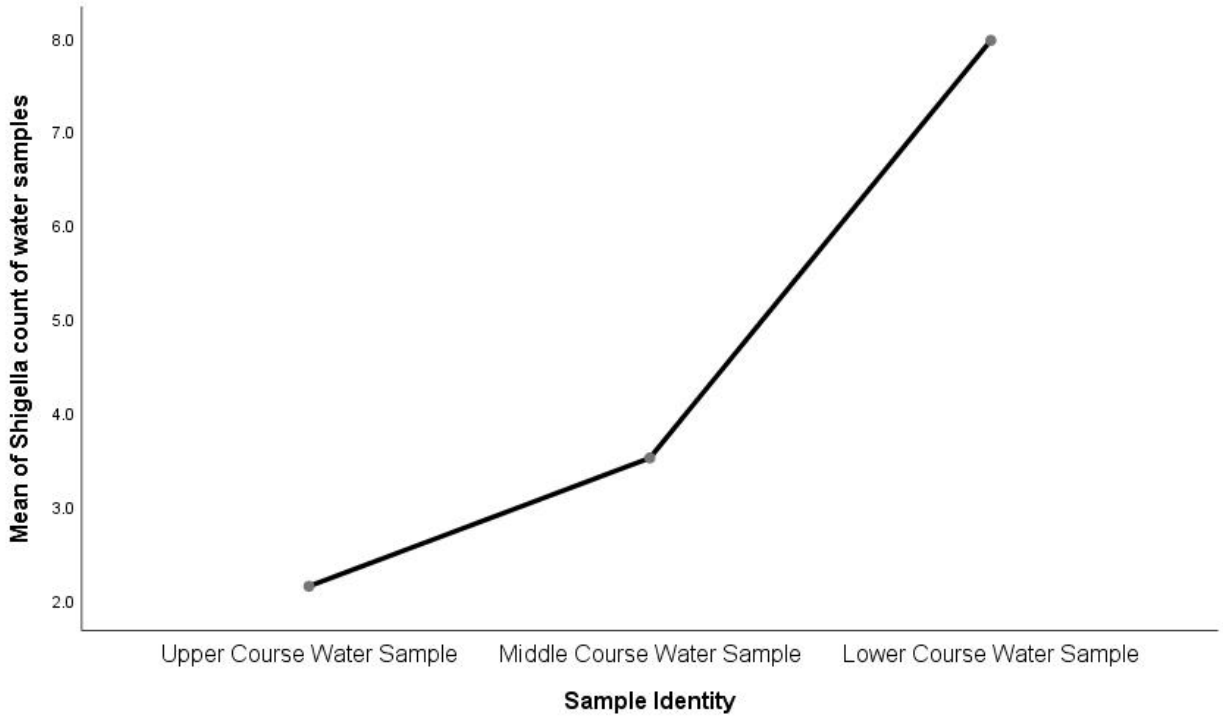


Figure 4.3:Mean *Shigella* count

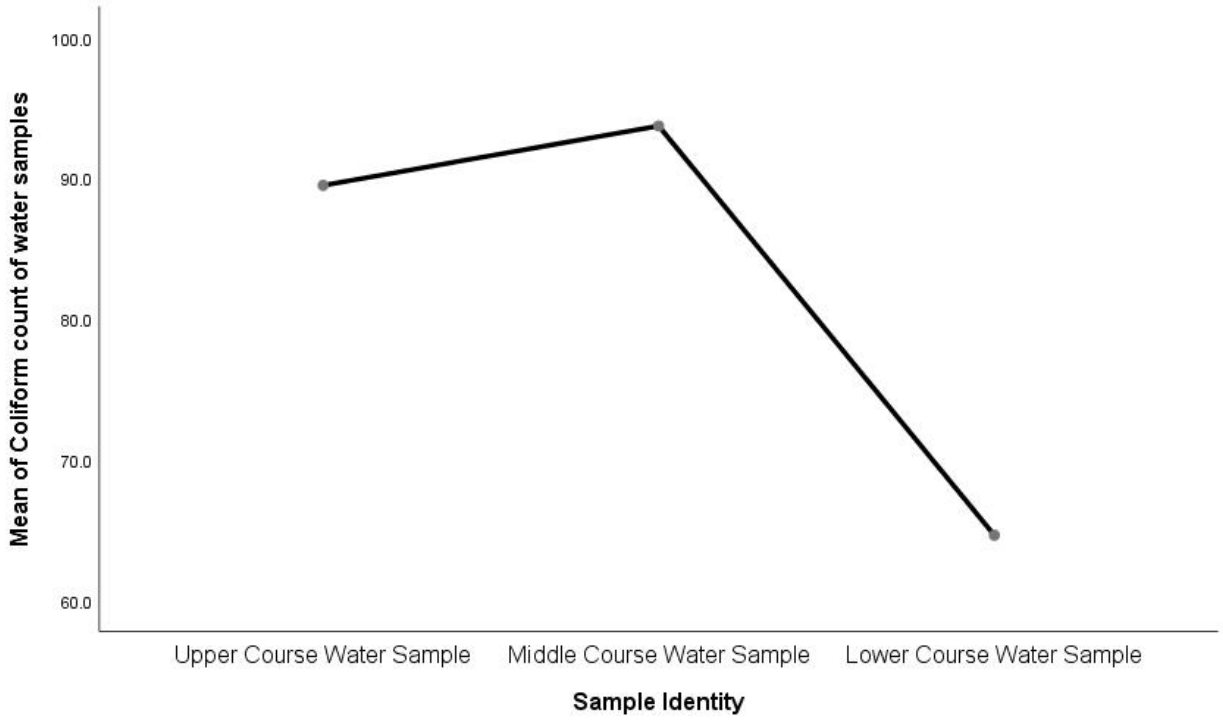


Figure 4:4 Mean Coliform count

Figure 4.5: indicates the mean values of *E. coli* count at the upper, middle, and, lower course. The upper course has the highest values while the lower course has the lowest values.

Figure 4.6: this indicates the mean values for temperature at the upper, middle, and lower course. The upper course has the highest values while the middle course has the lowest values.

Figure 4.7: this shows the mean values for turbidity at the upper, middle, and lower course. The lower course has the highest values while the upper course has the lowest values.

Figure 4.8: this represents the mean values for electrical conductivity at the upper, middle, and lower course. The upper course has the highest values while the lower course has the lowest values.

Figure 4.9: this shows the mean values for total dissolved solid at the upper, middle, and lower course. The upper course has the highest values while the lower course has the lowest values.

Figure 4.10: this shows the mean values for pH at the upper, middle, and lower course. The lower course has the highest values while the upper course has the lowest values.

Figure 4.11: this indicates the mean values for alkalinity at the upper, middle, and lower course. The middle course has the highest score while the upper course has the lowest values.

Figure 4.12: this indicates the mean values for nitrate at the upper, middle, and lower course. The upper course has the highest values while the middle course has the lowest values.

Figure 4.13: this represents the mean values for chromium at the upper, middle, and lower course. The upper course has the highest values while the middle course has the lowest values.

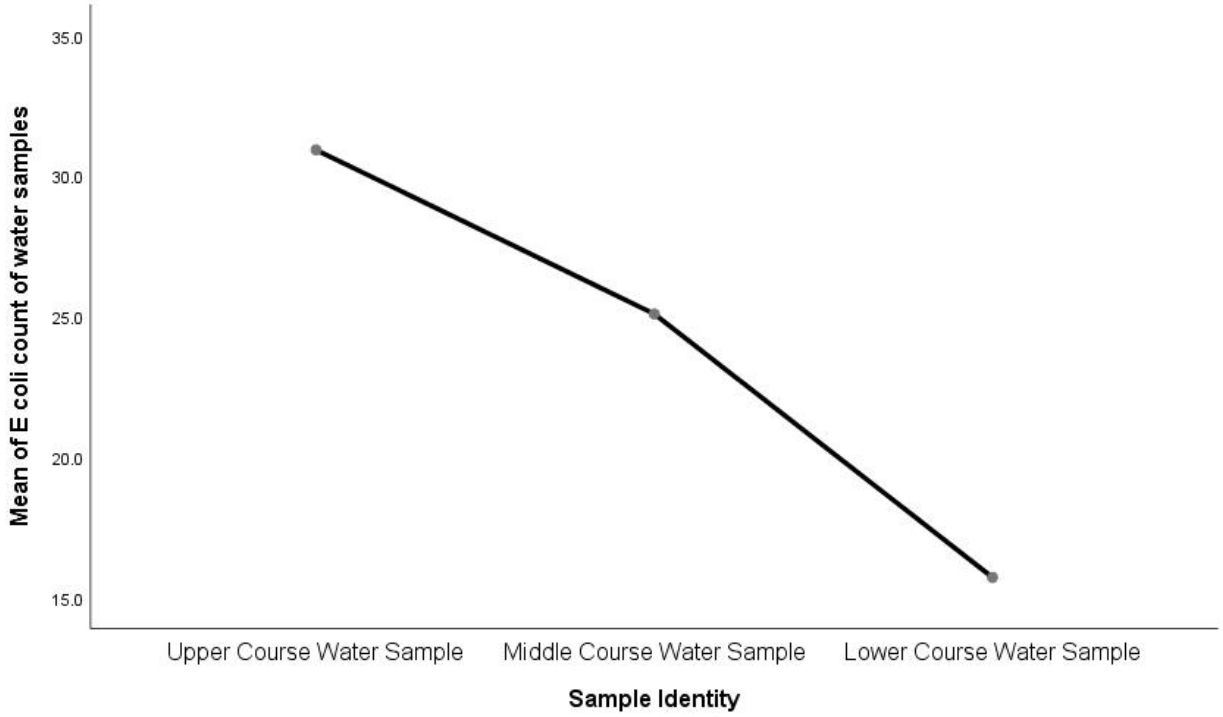


Figure 4.5: Mean *Escherichia coli* count

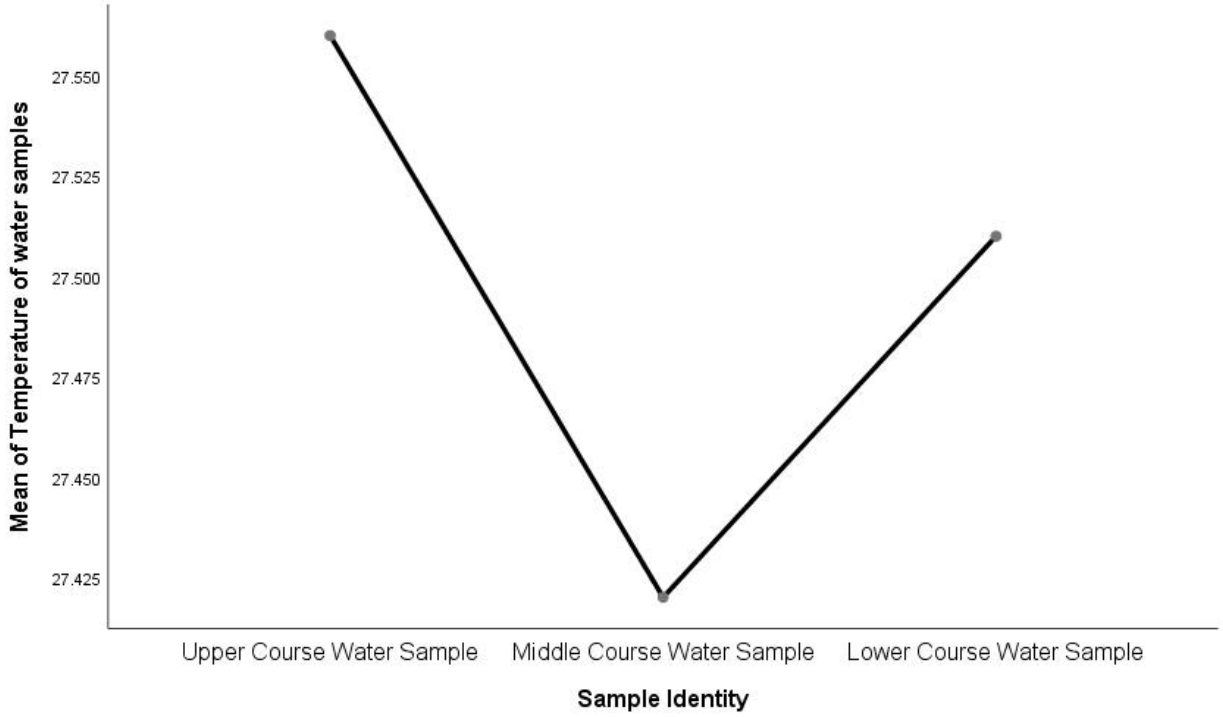


Figure 4.6: Mean Values of Temperature

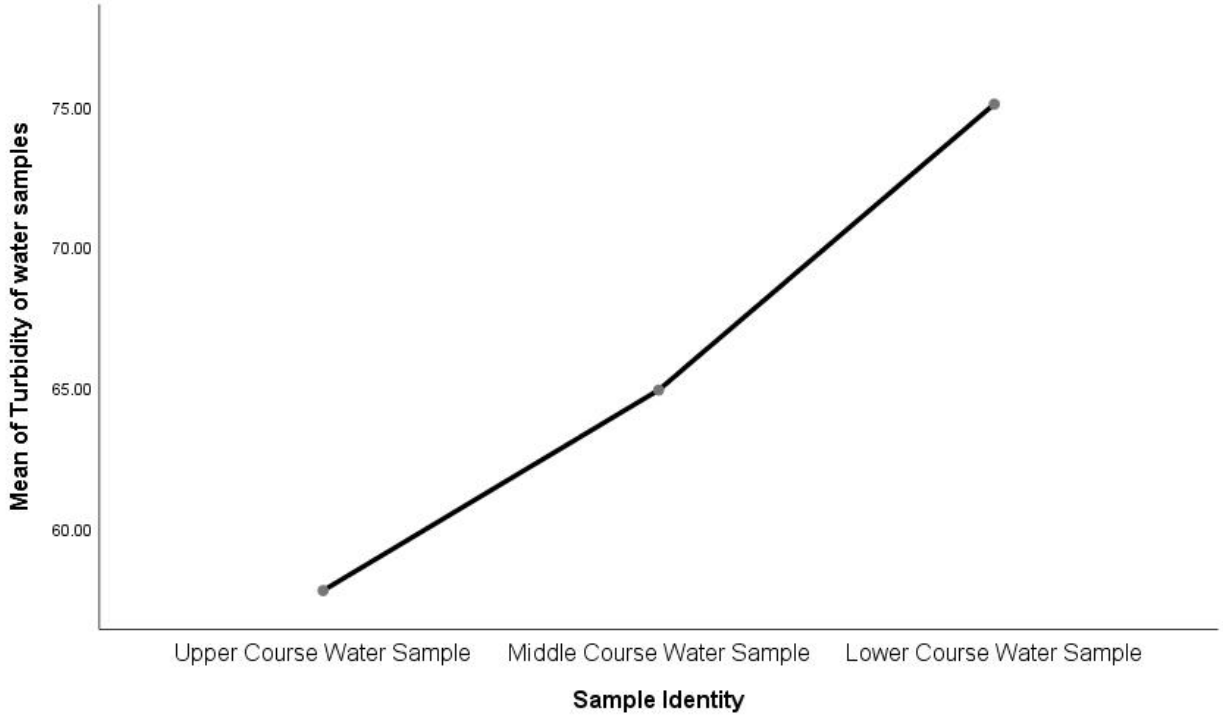


Figure 4.7: Mean Values of Turbidity

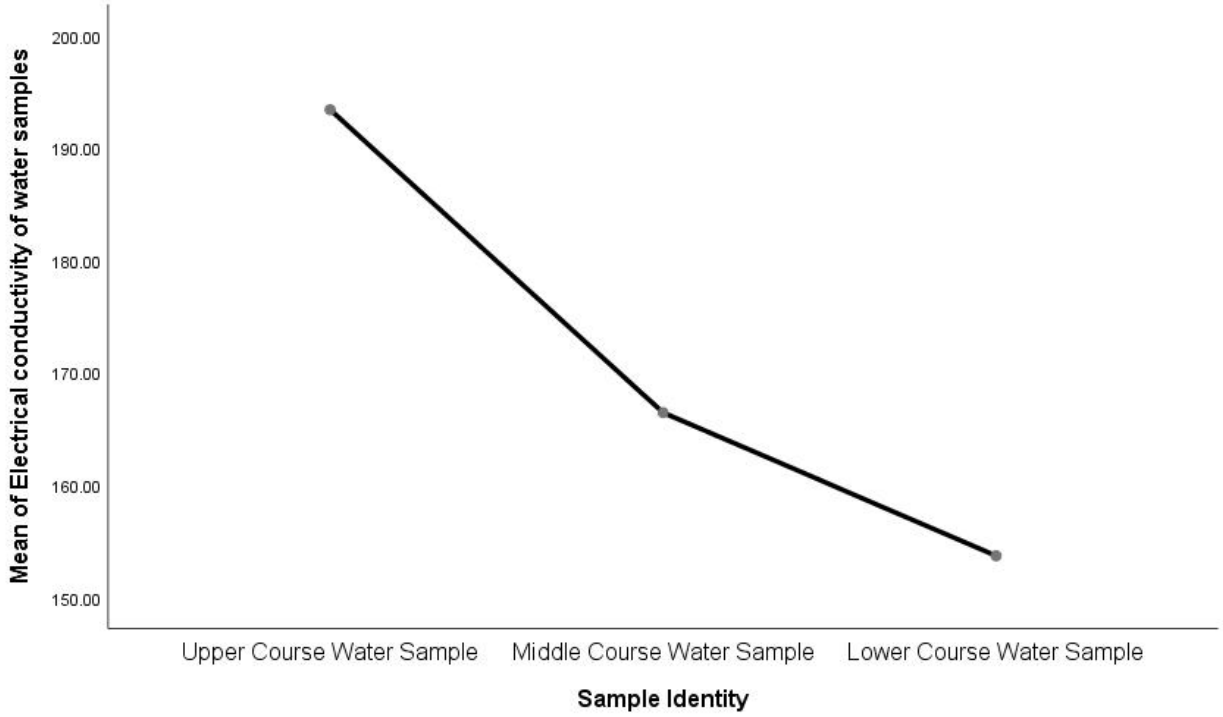


Figure 4.8: Mean Values of Electrical conductivity

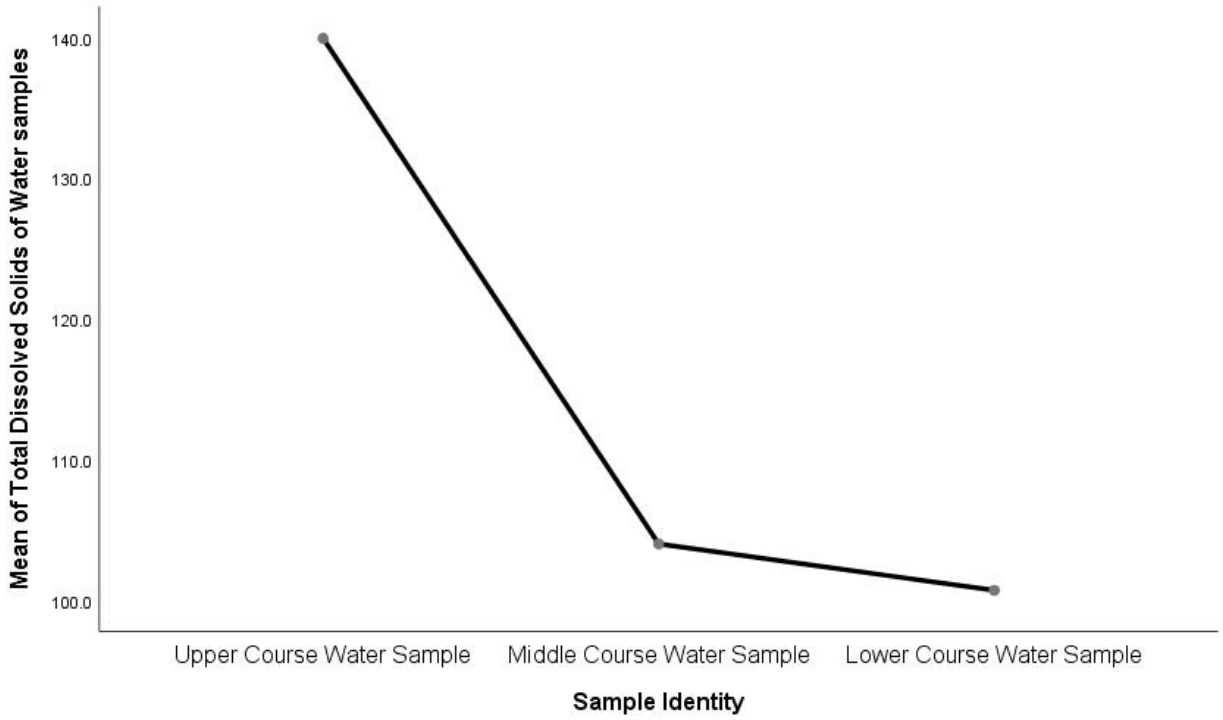


Figure 4.9: Mean Values of Total dissolved solid

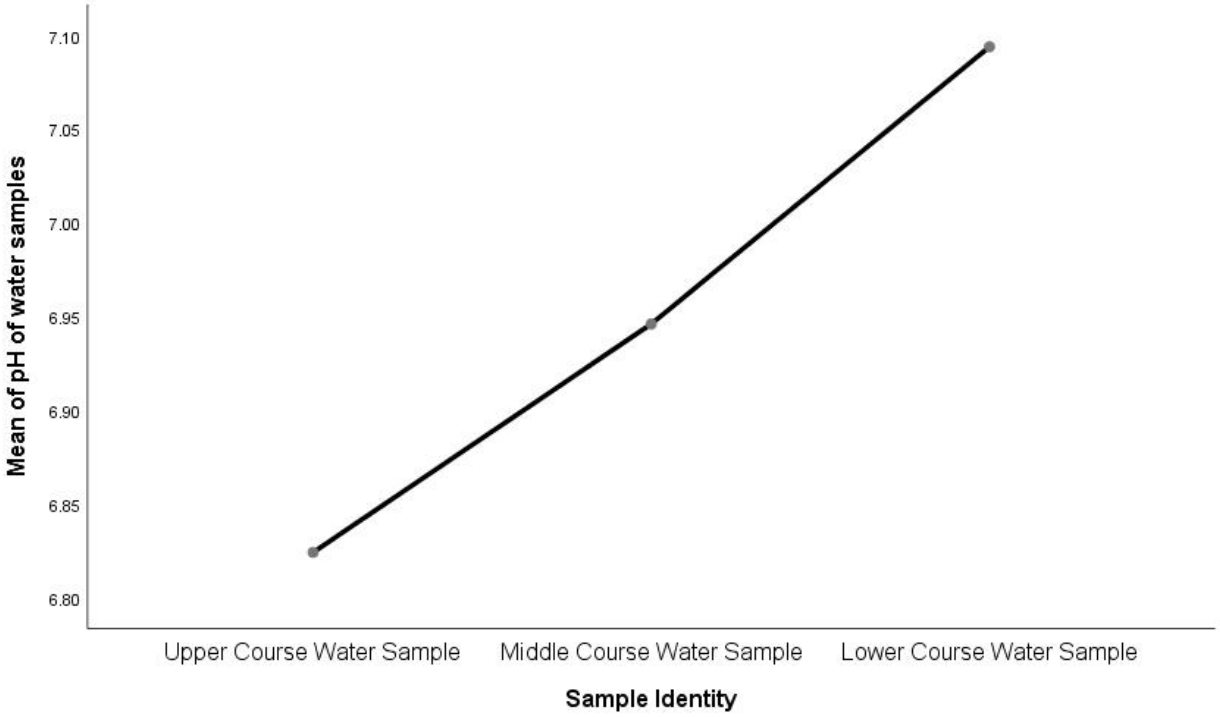


Figure 4.10: Mean Values of pH

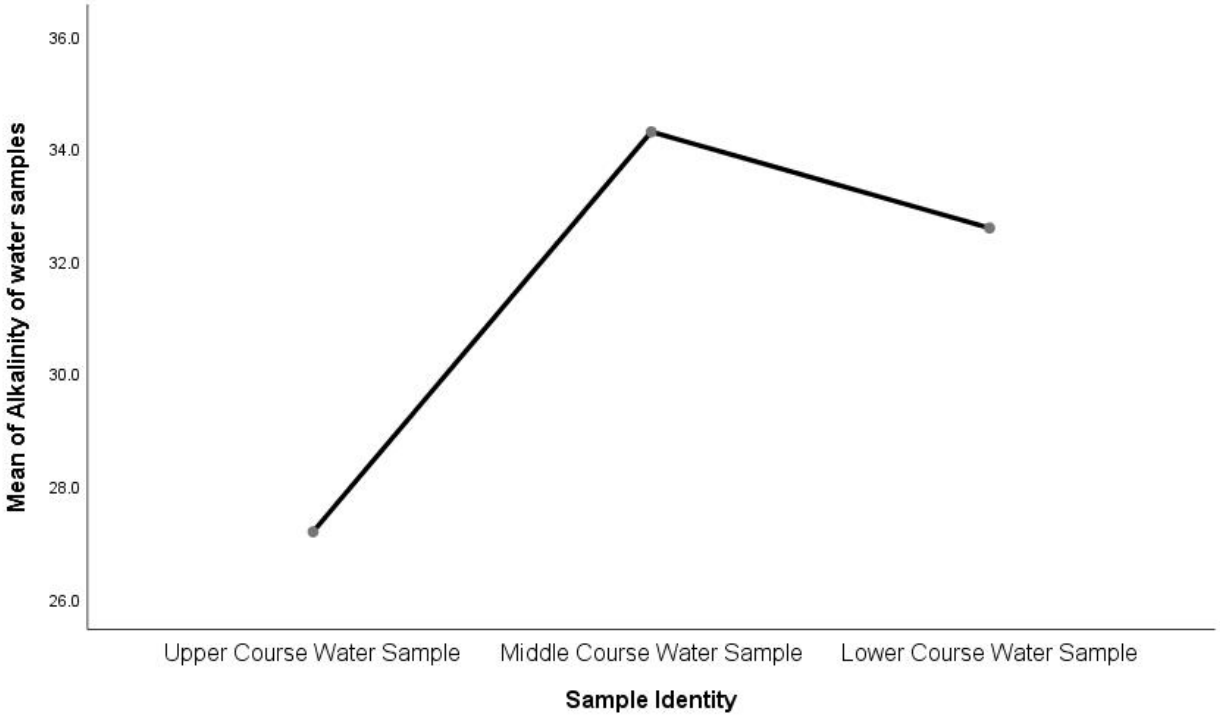


Figure 4.11: Mean Values of Alkalinity

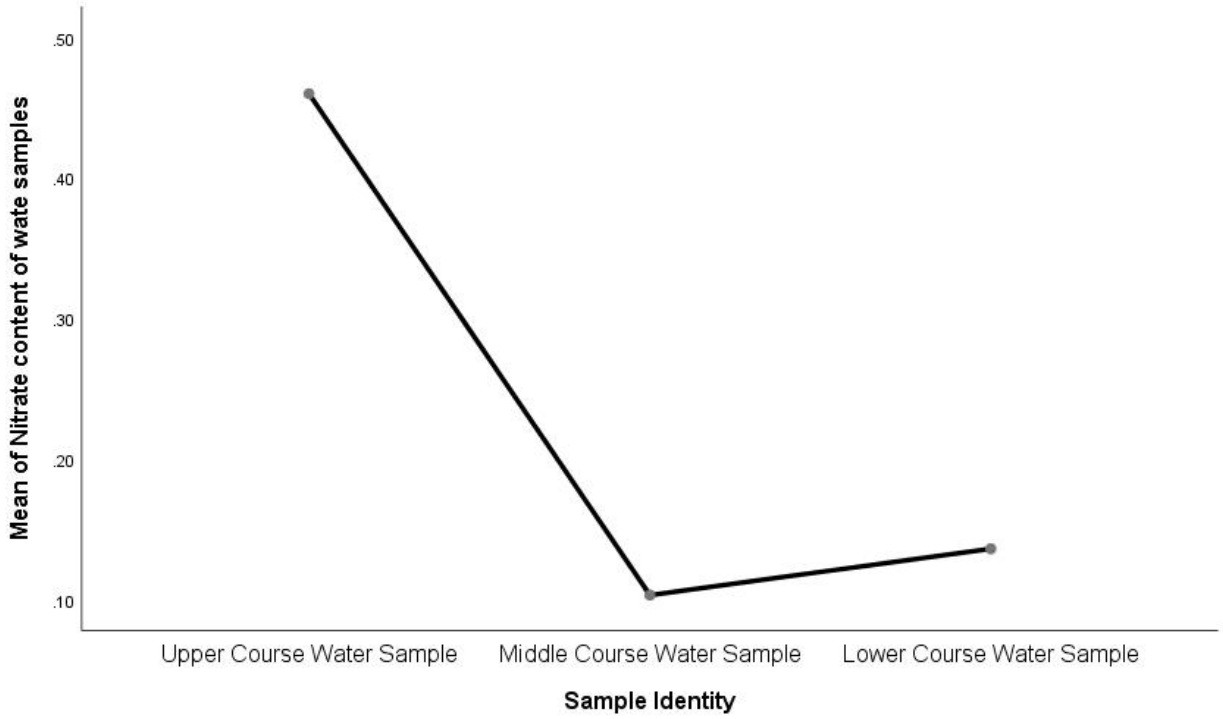


Figure 4.12: Mean Values of Nitrate

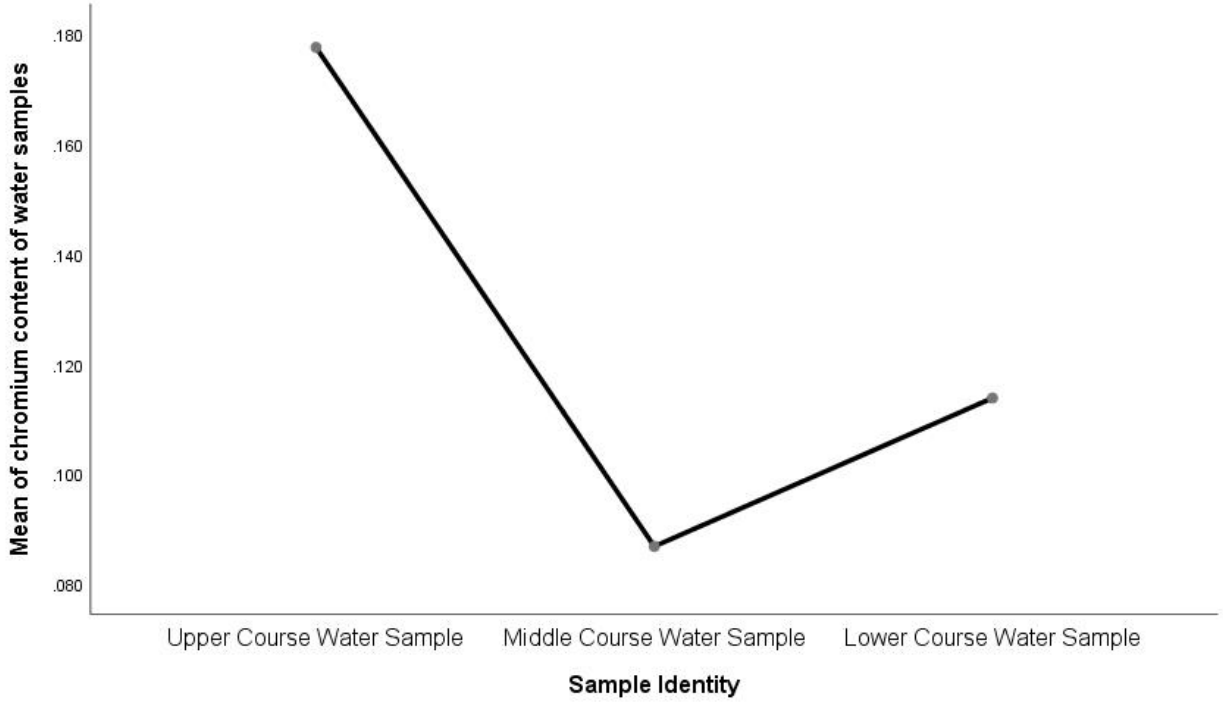


Figure 4.13: Mean Values of Chromium

Discussion

The microbiological data obtained from this study clearly showed high heterotrophic, coliform, *Escherichia coli, Salmonella*, and *Shigella* counts in the river. The high counts of organisms were due to heavy and frequent rainfall, pollutants (municipal, agricultural land runoff and stagnant ponds), fecal contaminations, that find their way into the river through drainage and flooding. This trend has also been reported by [1] and [11], they also observed high values of heterotrophic organisms, *E. coli, Salmonella, Shigella*, and Coliform during rainy months in the various sampling points on river Kaduna.

The mean values obtained from the upper course are significantly different with the mean values obtained at the lower course. The relatively high counts of heterotrophic organisms obtained at the middle and lower course might be due to additional contamination arising from washing, bathing, and swimming activities being carried out by the populace near this point, the values obtained are above the WHO/NSDWQ standard. This is in agreement with the reports of [8] and [6] who reported high heterotrophic counts in river Opuraja, Delta state. The results on coliforms recorded high values of coliform count, which is also above the WHO/NSDWQ standard. The presence of coliform may indicate a higher risk of pathogens being present in the water which may leads to waterborne diseases such as dysentery, typhoid fever, viral and bacterial gastroenteritis and hepatitis A [9]. This is in agreement with the reports of [8] and [6] who reported high coliform counts in river Opuraja, Delta state.

The results of this study indicated high values of *E. coli* count. The *E. coli* counts of the water samples exceeded the World Health Organization (WHO/NSDWQ) standard due to fecal contamination and farming activities**.** [12] reported *Escherichia coli* count in river water sample from Samaru Kaduna state were 33.75 ± 44.60 cfu/ml and 55.25 ± 96.69 cfu/ml, during rainy season, which indicate that these values are higher than WHO standard.

This research work indicated high values *Salmonella* and *Shigella spp*, these values were above the WHO/NSDWQ standard. This can be due to fecal contamination and agricultural activities. [12] reported *Salmonella* and *Shigella spp* count in river water samples from Samaru Kaduna state**,** they were 1.06 × 107 ± 2.37 × 107 cfu/ml and 201 ± 446.66 cfu/ml, and 75 ± 9.57 cfu/ml and 811 ± 1782.83 cfu/ml, these were also above the WHO standard. The results gotten from river Samaru in Kaduna state are in agreement with this research work because they both recorded values that are above the WHO/NSDWQ standard.

The pH values recorded were observed to be within the WHO/NSDWQ standard of 6.5 – 8.5, due to a smaller number of chemical pollutants in river Mayo-gwoi. [13] also reported pH values or river Larmude and nukkai in Taraba state to be between the range of 4.60 to 6.80 which by implication were lower than World Health Organization standards, the author' finding is not in agreement with the results of this research, this could be that the river received much chemical pollutant that was responsible for the acidic nature of the river. The results of total dissolved solid (TDS) were lower than the WHO/NSDWQ standard this is due to agricultural and residential runoff. [13] reported that the TDS values at river Larmude and Nukkai varied from 357 to 731 mg/L, which is far above the acceptable limits of surface water (300 mg/L). The highest value was obtained at Lamurde River. These results are not in agreement to the results on this research work. The results of turbidity were above the WHO/NSDWQ standard, the resultant high values may be attributed to the fact that, the river is within the highly turbulence region within the urbanized section of the town due to silt, clay and other suspended particles which may contribute to the high values as the samples. [13] in their work at river Larmude and Nukkai reported that values of turbidity ranges from 117.42 to 163.84 NTU, the values exceeded the allowable turbidity limits of between 5-10 NTU, this result is said to be in agreement with this research work.

The electrical conductivity values were below the WHO/NSDWQ standard; therefore, it implies that that the water sample contain low values of dissolved ions and other electrical ions dissolved in the water sample since the result is below the recommended standard. [13] also reported the electrical conductivity values of river Larmude and Nukkai, which ranged from 398 to 521 µS/cm with mean value of 452.33 µS/cm. The values are within the range that supports good quality water for irrigation practice [15]. These results are in agreement with the results from this research work. [12] reported that the conductivity and TDS concentration ranged widely from 102- 484 (µS/cm) and 51–242 mg/L in river Samaru Kaduna state. These results are also in agreement with this research work results.

The temperature values were found to be lower due frequent and heavy rainfall. [12] reported that the mean value of temperature in river Samaru Kaduna state was (28.07 ± 1.22 °C), these results are in agreement with tis research work. The values on alkalinity of the water samples were within the WHO/NSDWQ standard but some were below the standard, this can be due to agricultural and industrial runoff. [12] also reported the value of alkalinity obtained from a river water sample which was (26.33 ± 2.25 CaCO3mg/L), this is within the WHO standard and is also in agreement with the results from this research work. The results on chromium in the upper course and lower course were above the standard, this is due to industrial wastes, at the middle course most of the samples were below the WHO/NSDWQ standard and this is due to low concentration of industrial waste. [13] reported that chromium concentrations in river Larmude and Nukkai ranges from 0.00 to 0.03 mg/L, respectively, about 97.30% of the water samples show low concentrations of chromium. These results are not in agreement with the results obtained from this research. The results on nitrate were below the WHO/NSDWQ standard, this is as a result of agricultural runoff.

Conclusion

The bacteriological parameters analyzed in this study were not in compliance with WHO/NSDWQ standard for drinking water. The Physicochemical parameters analyzed in this study such as temperature, electrical conductivity, total dissolved solid, pH, alkalinity, and nitrate show compliance with the WHO/NSDWQ standard but chromium, and turbidity were above WHO/NSDWQ standard therefore, the water in river Mayo-gwoi Jalingo Taraba state is unsafe for drinking.

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