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# EVALUATION OF ENVIRONMENTAL FACTORS AND MORPHOLOGICAL CHARACTERISTICS OF MICROORGANISMS IN THE UTCUBAMBA BAGUA-AMAZON RIVER

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**ABSTRACT**

The objective of this study is to determine the environmental factors and morphological characteristics of the free-living microorganisms of the Utcubamba River, a study that was carried out along the Utcubamba River from the sampling point: Puente Bagua Grande, Trayec1, Bagua Chica, Dist Milagros1, Milagros2 of the Amazonas Region Peru. Using the quantitative and descriptive methodology, data collected in situ such as T°, pH, E.C., TDS, Salinity and the morphological characteristics of microorganisms divided into free-living groups determined in the laboratory of the University and as an environmental instrument, the ECAs of water for rivers were used; carried over a period of six months. As a result, the pH fluctuates between 8.98 found in the Milagros River1 and 7.45 recorded under Puente Bagua Grande with an average of 8.30. The maximum temperature is 27.7 °C recorded in the Bagua Chica River and the minimum is 21.5 °C obtained in the Milagros River2 with an average of 24.5 °C. C.E. fluctuates between 490 mmhos/cm recorded in the Bagua Chica River and 139.2 mmhos/cm obtained in the Puente Bagua Grande River with an average of 331.3 mmhos/cm. TDS fluctuates between 342 mg/l obtained in the Bagua Chica River and 97.3 mg/l found in the Puente Bagua Grande site with an average of 232.3 mg/l; Salinity fluctuates from 0.00 to 0.2 g/l which is obtained in the 05 sampling points with an average of 0.18 g/l and in characterization of the microorganisms there is in the Group of Protozoa: Vorticella, Paramecium, Amoeba, Tetrahymen, Group of Algae: Euglena, Cosmarium, Diatomaceae, Zygnema and in Metazoan Group: Daphnia, Rotiferos is observed in all samplings. Scianoficeae Group: Spirulina, Nostoc sp, Oscillatoria; Chlorophyta Group: We only have Pediastrum. In conclusion, in the analysis of variance in the environmental parameters for the aforementioned places, the interpretation in Rows does not exist significant difference and for columns there is a highly significant difference, therefore, the hypothesis is rejected.

***KEYWORDS: Protozoa, Algae, Metazoans, Scianophyceae, Chlorophyta, free life, Aquatic microorganisms.***

## 1. INTRODUCTION

Water pollution occurs through the direct or indirect introduction of liquid solid substances, gaseous substances, as well as heat energy, among others. This contamination causes damage to living organisms in the aquatic environment and also represents a danger to human health. (Ministry of Education, 2005) Water pollution endangers public health, complicates and makes the supply of drinking water to populations and industry more expensive, harms fishing and agriculture and nullifies the strict value of surface courses (Atillo, 2009) Sewage is fecal material that contains a large amount of microorganisms on all pathogens such as bacteria, viruses that cause typhoid diseases, dysentery, flu, poliomyelitis, etc. and by decomposition of organic matter such as corpses, which favor the multiplication of bacteria and microorganisms, taking away oxygen from aquatic beings. Modern agriculture that uses fertilizers, insecticides and pesticides that pass into the waters when irrigating crop fields. Radioactivity and waste from nuclear power plants. (Portugal, 2001)

At the beginning of the last century, the main environmental problems were related to the channeling of rivers, extraction of quarry material, inefficient use of water and soil erosion; with the development of the "green revolution", these have worsened and others have appeared, such as aquifer depletion, soil salinization, loss of diversity, excessive use of agrochemicals, and inadequate disposal of the by-products of this aquatic activity (Lenat and Crawford, 1994; Davis et al., 2003; Jergentz et al., 2005 cited by Valcárcel, 2011). In this sense, the discharge of untreated municipal and industrial domestic wastewater is one of the problems responsible for the current deterioration of most water bodies (Cardona, 2003).

Yana (2014) mentions the results of the environmental indicators that in the Torococha River presented average temperatures that ranged between 13.33 and 11.66°C, an average pH between 7.46 and 6.78, the area with the highest average for the flow was Zone C (3.19 m3 /s) and the lowest Zone B (0.17 m3 /s) and for the months of January (1.52 m3 /s) it showed a higher average compared to August (1.05 m3 / s), the area with the highest average BOD5 is Zone C (78.64 mg/l) and the lowest is Zone A (15.15 mg/l), April (81.55 mg/l) had the highest average BOD5 and the lowest in January (25.06 mg/l). (Yana, 2014).

Teves (2016) in the results in the area of physicochemical study of the water quality of the Cacra River Lima Region, affect the environment, such as discharge into the river of untreated domestic wastewater, residues from agricultural activities and water consumption for the population and it is determined that the parameters studied in the Cacra River did not exceed the levels established in the national environmental quality standard for water intended for irrigation of vegetables and animal drink. However, the Paluche River, one of the contributors to the Cacra River, does not meet the values established by the ECA for phosphates (1.052 mg/L), Fe (1.005 mg/L) and pH (6.03).

Tamani (2014). In the results obtained from the water quality of the Rio Negro in the province of Padre Abad, Aguaytia Peru; found that dissolved oxygen, its highest value was 6.78 mg/l and the lowest was 4.82 mg/l, the conductivity recorded with the minimum value was 10 uS/cm and the maximum was 41 uS/cm, a pH ranging from slightly acidic to slightly basic, the water temperature remained almost constant with the highest value of 27.7 °C and a minimum of 22.9 °C, Total dissolved solids ranged from 8 mg/l minimum to maximum 46 mg/l.

Zhen (2009). In their research called "Physicochemical and bacteriological quality of water for human consumption in the micro-basin of the Victoria stream" in Costa Rica, they showed the results of the following: the average annual temperature of the water in the stream was 25°C with a minimum of 22.5°C and a maximum of 27.3 °C, the average annual pH was 5.67 with a minimum of 3.85 and a maximum of 7.51, for conductivity, there was an annual mean of 217.5 uS/cm with a minimum of 87.5 and a maximum of 285 uS/cm.

Gil (2014). In this research work on the determination of water quality through physical-chemical variables in the Garagoa River basin, macroinvertebrates are detailed as bioindicators. The results indicated that the conductivity maintained the highest value in the dry season, with (0.274 ms/cm), the total solids presented a maximum value of 261.10 mg/l, the highest temperature was presented with a value of 24.3°C and the lowest with a value of 16°C, the highest pH was 9.25, and lower with a value of 7.18.

Martínez (2006). In the results in the multiple uses of water, Monterrico in Guatemala showed that the highest and lowest values of each parameter were: a pH with its maximum value that was 7.99 and the minimum of 5.92, the temperature showed a value that oscillates with a maximum that was 34.5 °C and a minimum of 25 °C, the maximum conductivity was 1878 uS/cm, and a minimum of 0.5 uS/cm, in the total dissolved solids a maximum was obtained that was 934 mg/l, and a minimum of 0.0 mg/l, total dissolved solids showed a maximum value that was 34.441 mg/l and a minimum of 148 mg/l. The data obtained

reflected the conditions prevailing in the canal water in the normal one-year period, covering both the dry and rainy seasons.

Rivas *et al*. (2005). In the scientific journal "Contribution of the main tributary rivers to the pollution and eutrophication of Lake Maracaibo" in Venezuela. They found an average of 28.8 ± 1.84°C in temperature, pH in the water varying tending to neutrality in a range of 6.28 to 8.04. For all rivers, the estimated global average value of total suspended solids (TSS) was 250.03 mg/l. The differences between BOD5 values in relation to the rest of the rivers above 2 mg/l are due to the low velocity in them, which can increase the accumulation of organic matter.

Javier (2003). In his study of surface waters in the micro-basin of the La Soledad River, Valle de Angeles", Honduras. The parameters showed a maximum temperature of 27.75 °C and a minimum of 19.25 °C, the pH ranges from 3.19 to 7.97, the total dissolved solids had a maximum value of 244.61 mg/l and a minimum of 46.38. It concludes that in this sense, the lower part of the Agua Amarilla and San Francisco streams were more contaminated. On the other hand, high concentrations of organ-chlorinated pesticides found in water samples suggest that horticultural crops have a negative impact on aquatic health.

ANA (2012). In the monitoring of the water quality of the Coata, Ilave, Illpa, Pasto Grande reservoir and Margaritani river basins, carried out by the national water authority. The following is reached: for the areas that are located before the intake of the drinking water plant and after the discharge of wastewater from the municipal field, it has a conductivity of 580 and 584 uS/cm, with a temperature of 17.5 and 16.5 °C, a dissolved oxygen with 7.31 and 6.76 mg/l a pH that was 8.44 and 8.73, a biochemical oxygen demand that was 3 and 4 mg/l, the chemical oxygen demand between 10 and 18 mg/l, fecal coliforms 7.8 and 220 NMP/100ml.

Custodio and Pantoja (2012). The objective is to identify the impacts generated by anthropogenic activities on the water quality of the Cunas River in Colombia, demonstrated in the results that the maximum pH was 8.37 and the lowest of 8.04, the maximum conductivity was 450 uS/cm and the minimum of 430 uS/cm, with a dissolved oxygen that was 7.28 mg/l and the minimum of 6.33 mg/l, the temperature fluctuated with a maximum of 14.8 °C and a minimum of 11.8 °C, for total dissolved solids its maximum value was 315 and its minimum of 301 mg/l, can be considered as a slightly moderate impact.

## METHODOLOGY AND MATERIALS

The type of research to be used is the qualitative and descriptive methodology, which allows us to know the quality of the water using the equipment called PORTABLE MULTIPARAMETER, COMPLETE KIT (H19829-03041) HANNA INSTRUMENTS brand determining the physical and chemical parameters they are compared with the optimal environmental parameters according to the national ECAs, the samplings are determined IN SITU and for the identification of the microorganisms the samples are taken of water samples from the five sites and are determined in the laboratory, considering without modifying the conditions of the contamination of the Utcubamba-Bagua River. The statistical design is applied completely randomized with a confidence level at the level of 0.05%.

### Study Area

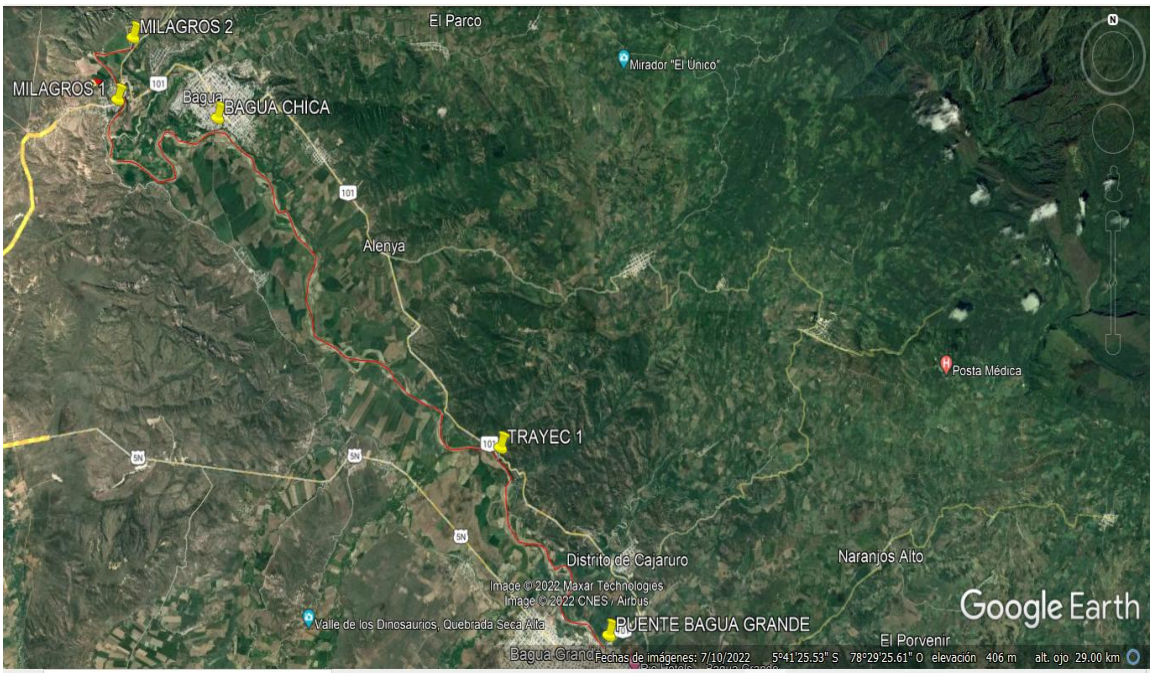
The Amazonas region is located in the northeastern part of the country, bordered on the north by the Republic of Ecuador, on the east by the Department of Loreto, and on the south by the Department of Agriculture. La Libertad and San Martín and to the west with the Department of Cajamarca. It covers 39,249,000 km2 mostly, covered rich in biodiversity, where the capital, Chachapoyas de Amazonas Department, is located at an altitude of 2,335 meters above sea level (IIAP/GRA, 2010). According to the (INEI 2007). In addition to the 84 districts that make it up, it has a population of 375,993 inhabitants, where 44.15% are located in the urban area and 55.85% in the rural area, being the province of Utcubamba with the highest population density.

### Localization

The present research work was carried out in the main channel of the Utcubamba river basin, located from the river below the Bagua Grande Bridge to the district of Milagros, which is located between the minimum level of 420 meters above sea level and the maximum level of 2483 meters above sea level, occupying the provinces of Bagua, Bongará, Chachapoyas, Luya and Utcubamba, representing 15.32% of the regional territory.


Map of Peru


Map of Amazon




Location of the five sampling points of the Utcubamba River of Bagua-Amazonas (Yellow dots) and red is the Utcubamba River

**Data analysis**

In order to evaluate the levels of wastewater contamination of the physical, chemical and biological parameters, an exploratory analysis of the data was carried out, that is, the descriptive statistics (number of data, minimum, maximum, mean, standard deviation and coefficient of variability) were obtained for each parameter, which allows us to make the evaluations, using the statistical software analysis of variance design design for a randomized complete block design (DBCA).

## RESULTS

### pH

| SAMPLING POINT | 16/07/2023 | 24/09/2023 | 1/10/2023 | 3/12/2023 | AVERAGE |
|---|---|---|---|---|---|
| B.G. BRIDGE | 7.45 | 8.93 | 8.64 | 8.69 | 8.4275 |
| TRAYECT 1 | 7.5 | 8.66 | 8.41 | 8.86 | 8.3575 |
| BAGUA CHIC | 7.62 | 8.55 | 8.24 | 7.98 | 8.0975 |
| MIRACLES 1 | 7.72 | 8.27 | 8.15 | 8.98 | 8.28 |
| MIRACLES 2 | 7.65 | 8.26 | 8.16 | 7.95 | 8.005 |

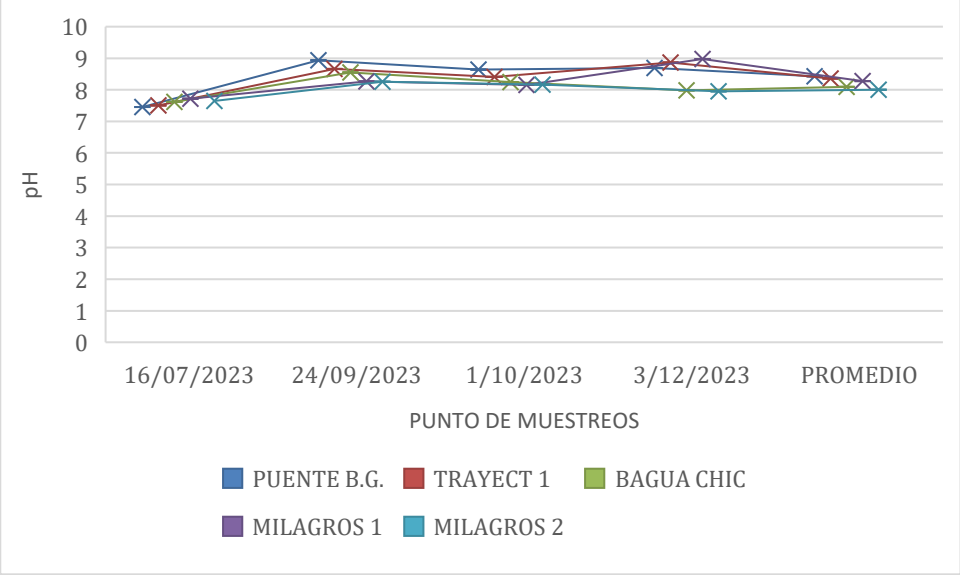
SUMMARY

| *Groups* | *Account* | *Sum* | *Average* | *Variance* |
|---|---|---|---|---|
| 16/07/2024 | 5 | 37.94 | 7.588 | 0.01227 |
| 24/09/2024 | 5 | 42.67 | 8.534 | 0.07943 |
| 1/10/2024 | 5 | 41.6 | 8.32 | 0.04285 |
| 3/12/2024 | 5 | 42.46 | 8.492 | 0.24217 |
| AVERAGE | 5 | 41.1675 | 8.2335 | 0.0314706 2 |

ANALYSIS OF VARIANCE

| *Origin of the variations* | *Sum of squares* | *Degrees of freedom* | *Average of squares* | *F* | *Probability* | *Critical value for F* |
|---|---|---|---|---|---|---|
| Between groups | 2.906375 | 4 | 0.72659375 | 8.9001768 5 | 0.00026847 | 2.8660814 |
| Within the groups | 1.6327625 | 20 | 0.08163813 | | | |
| Total | 4.5391375 | 24 | | | | |

Figure 1. pH Parameters. In original language: Spanish




In Graph 1. On July 16, the pH behavior is slightly alkaline between 7.45-7.72, occurring in the five sampling points, and on September 24, it fluctuates between 8.26-8.93, however, on October 1, it fluctuates between 8.16-8.64 and on December 3, it fluctuates between 7.95-8.98. In the behavior, the ascent from the first date to the end is appreciated, which indicates according to the ECAs of the water of the rivers the microorganisms can have a normal life.

**TEMPERATURE (C°)**

| **SAMPLING POINT** | 16/07/2023 | 24/09/2023 | 1/10/2023 | 3/12/2023 | AVERAGE |
|---|---|---|---|---|---|
| B.G. BRIDGE | 25 | 23.5 | 21.6 | 23.4 | 23.375 |

| | | | | | |
|---|---|---|---|---|---|
| TRAYECT 1 | 25.2 | 24.2 | 22.6 | 26.6 | 24.65 |
| BAGUA CHIC | 25.3 | 24.8 | 21.6 | 27.7 | 24.85 |
| MIRACLES 1 | 26.2 | 24.3 | 21.8 | 27.3 | 24.9 |
| MIRACLES 2 | 27 | 23.7 | 21.5 | 26.9 | 24.775 |

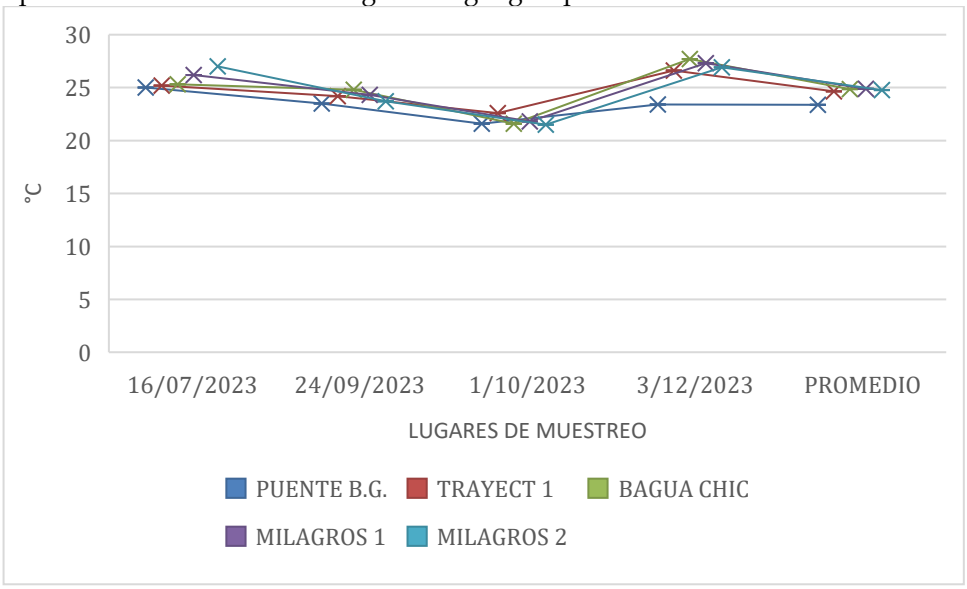
SUMMARY

| *Groups* | *Account* | *Sum* | *Average* | *Variance* |
|---|---|---|---|---|
| 16/07/2023 | 5 | 128.7 | 25.74 | 0.708 |
| 24/09/2023 | 5 | 120.5 | 24.1 | 0.265 |
| 1/10/2023 | 5 | 109.1 | 21.82 | 0.202 |
| 3/12/2023 | 5 | 131.9 | 26.38 | 2.947 |
| AVERAGE | 5 | 122.55 | 24.51 | 0.4114375 |

ANALYSIS OF VARIANCE

| *Origin of the variations* | *Sum of squares* | *Degrees of freedom* | *Average of squares* | *F* | *Probability* | *Critical value for F* |
|---|---|---|---|---|---|---|
| Between groups | 62.07 | 4 | 15.5175 | 17.114496 4 | 3.0507E-06 | 2.8660814 |
| Within the groups | 18.13375 | 20 | 0.9066875 | | | |
| Total | 80.20375 | 24 | | | | |

Figure 2. Temperature Parameter °C. In original language: Spanish




In Graph 2, temperatures initially fluctuate between 25-27°C recorded on July 16 and drop to October 1, and then rise between 23.4-27.7°C on December 3. In behavior, it indicates that free-living microorganisms adapt to the change in temperature gradually.

**ELECTRICAL CONDUCTIVITY (E.C.)**

| **SAMPLING POINT** | 16/07/2023 | 24/09/2023 | 1/10/2023 | 3/12/2023 | AVERAGE |
|---|---|---|---|---|---|
| B.G. BRIDGE | 444 | 350 | 214 | 139.2 | 286.8 |
| TRAYECT 1 | 395 | 397 | 326 | 147.1 | 316.275 |
| BAGUA CHIC | 490 | 411 | 351 | 150.5 | 350.625 |
| MIRACLES 1 | 480 | 417 | 355 | 144.5 | 349.125 |
| MIRACLES 2 | 488 | 417 | 363 | 143.9 | 352.975 |

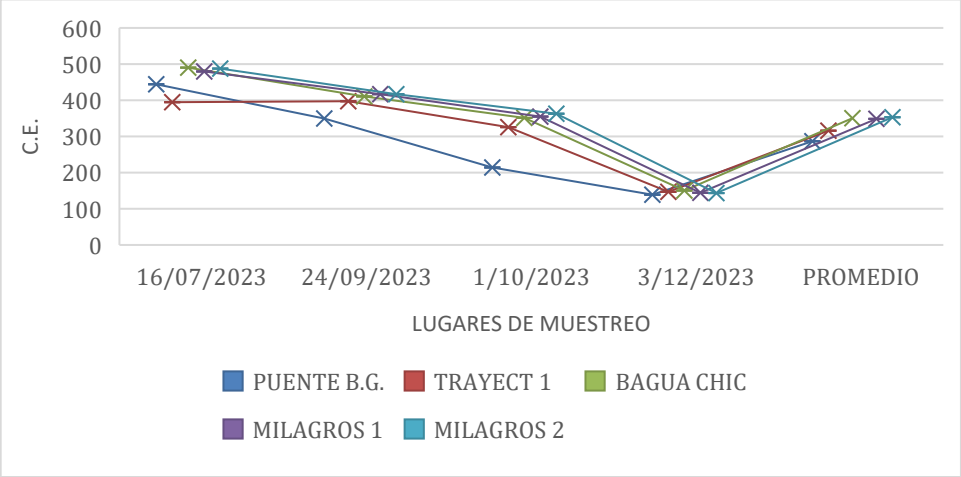
SUMMARY

| *Groups* | *Account* | *Sum* | *Average* | *Variance* |
|---|---|---|---|---|
| 16/07/2023 | 5 | 2297 | 459.4 | 1640.8 |
| 24/09/2023 | 5 | 1992 | 398.4 | 798.8 |
| 1/10/2023 | 5 | 1609 | 321.8 | 3822.7 |
| 3/12/2023 | 5 | 725.2 | 145.04 | 17.438 |
| AVERAGE | 5 | 1655.8 | 331.16 | 841.723625 |

ANALYSIS OF VARIANCE

| *Origin of the variations* | *Sum of squares* | *Degrees of freedom* | *Average of squares* | *F* | *Probability* | *Critical value for F* |
|---|---|---|---|---|---|---|
| Between groups | 278474.896 | 4 | 69618.7242 | 48.879519 | 0.00000001 | 2.8660814 |
| Within the groups | 28485.8465 | 20 | 1424.29233 | | | |
| Total | 306960.743 | 24 | | | | |

Figure 3. Electrical Conductivity Parameter (E.C.) . In original language: Spanish




In Graph 3. We have the behavior of the E.C. initially appreciated with high values between 395-490 mmhos/cm observed in the five places of the sampling point and gradually decreases to date December 3 with values between 139.2-144.5 mmhos/cm. This indicates that it has a mutual relationship with the salinity content, with the presence of carbonates, which allows there to be conductors that microorganisms require for the metabolism process.

**TOTAL DISSOLVED SOLIDS (TDS)**

| **SAMPLING POINT** | 16/07/2023 | 24/09/2023 | 1/10/2023 | 3/12/2023 | AVERAGE |
|---|---|---|---|---|---|
| B.G. BRIDGE | 320 | 276 | 152 | 97.3 | 211.325 |
| TRAYECT 1 | 290 | 275 | 228 | 97.4 | 222.6 |
| BAGUA CHIC | 342 | 288 | 240 | 103 | 243.25 |
| MIRACLES 1 | 321 | 292 | 241 | 100 | 238.5 |
| MIRACLES 2 | 342 | 290 | 253 | 99.4 | 246.1 |

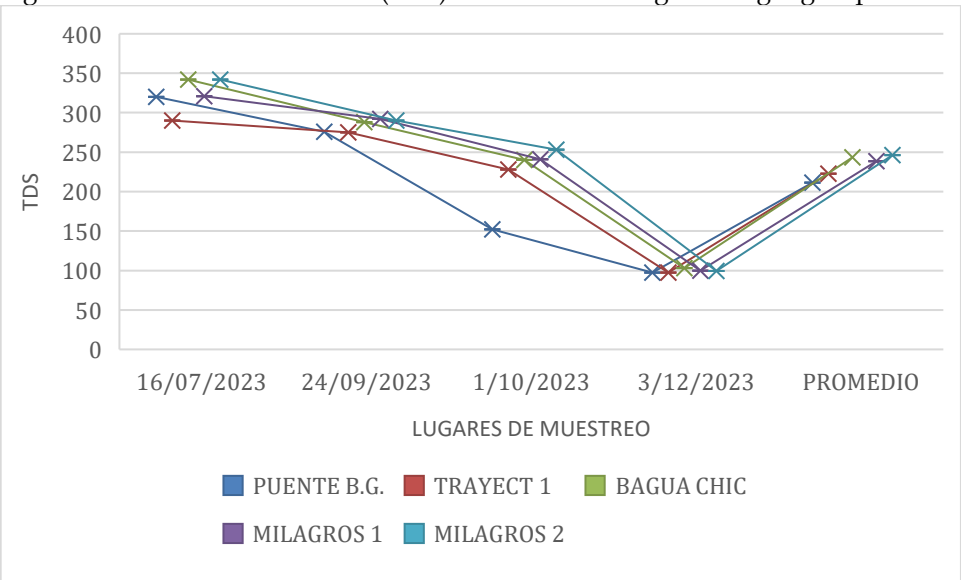
SUMMARY

| *Groups* | *Account* | *Sum* | *Average* | *Variance* |
|---|---|---|---|---|
| 16/07/2023 | 5 | 1615 | 323 | 456 |
| 24/09/2023 | 5 | 1421 | 284.2 | 65.2 |
| 1/10/2023 | 5 | 1114 | 222.8 | 1644.7 |
| 3/12/2023 | 5 | 497.1 | 99.42 | 5.432 |
| AVERAGE | 5 | 1161.775 | 232.355 | 220.702 |

ANALYSIS OF VARIANCE

| *Origin of the variations* | *Sum of squares* | *Degrees of freedom* | *Average of squares* | *F* | *Probability* | *Critical value for F* |
|---|---|---|---|---|---|---|
| Between groups | 143337.162 | 4 | 35834.2904 | 74.903388 4 | 0.000000 01 | 2.866081 4 |
| Within the groups | 9568.136 | 20 | 478.4068 | | | |
| Total | 152905.298 | 24 | | | | |

Figure 4. Total Dissolved Solids (TDS) Parameter. In original language: Spanish




In Graph 4. The behavior of TDS is initially seen on July 16, with high values between 290-342 mg/L and a decrease that decreases between 97.3-103 mg/L occurred on December 3. The accumulation of solids there is a high content of solids, this is due to the same characteristics of the color of the water, it presents an earth color and as due to self-pollution the water loses color that is almost clear in color that has a certain relationship with dissolved oxygen present in the river.

**SALINITY**

DATE: JULY 16, 2023

| **SAMPLING POINT** | 16/07/2023 | 24/09/2023 | 1/10/2023 | 3/12/2023 | AVERAGE |
|---|---|---|---|---|---|
| B.G. BRIDGE | 0.2 | 0.2 | 0.2 | 0 | 0.15 |
| TRAYECT 1 | 0 | 0.2 | 0.1 | 0 | 0.075 |
| BAGUA CHIC | 0.2 | 0.1 | 0.2 | 0 | 0.125 |

| | | | | | |
|---|---|---|---|---|---|
| MIRACLES 1 | 0.2 | 0.2 | 0.2 | 0 | 0.15 |
| MIRACLES 2 | 0.2 | 0.2 | 0.2 | 0 | 0.15 |

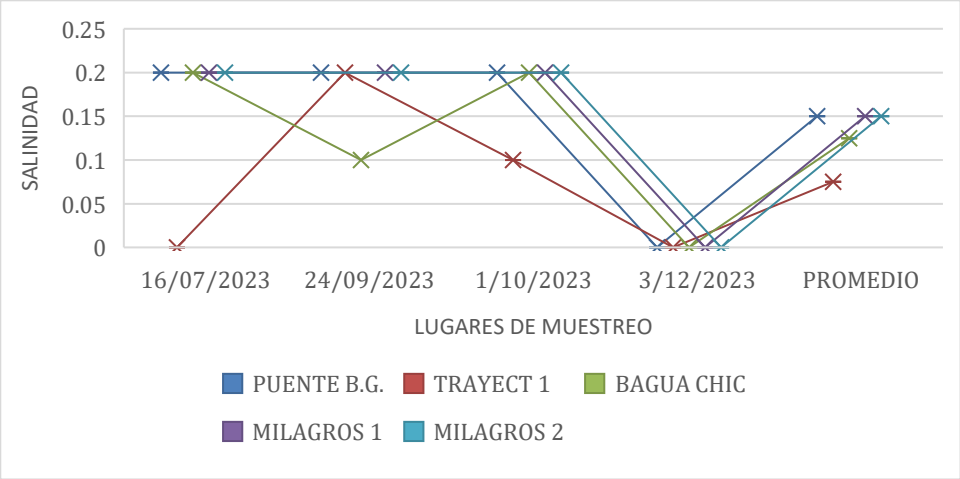
SUMMARY

| *Groups* | *Account* | *Sum* | *Average* | *Variance* |
|---|---|---|---|---|
| 45123 | 5 | 0.8 | 0.16 | 0.008 |
| 45193 | 5 | 0.9 | 0.18 | 0.002 |
| 45200 | 5 | 0.9 | 0.18 | 0.002 |
| 45263 | 5 | 0 | 0 | 0 |
| AVERAGE | 5 | 0.65 | 0.13 | 0.0010625 |

ANALYSIS OF VARIANCE

| *Origin of the variations* | *Sum of squares* | *Degrees of freedom* | *Average of squares* | *F* | *Probability* | *Critical value for F* |
|---|---|---|---|---|---|---|
| Between groups | 0.114 | 4 | 0.0285 | 10.9090909 | 0.000001 | 2.8660814 |
| Within the groups | 0.05225 | 20 | 0.0026125 | | | |
| Total | 0.16625 | 24 | | | | |

Figure 5. Salinity Parameter . In original language: Spanish




In Graph 5. The behavior of the salinity content fluctuates between 0.0-0.2 ppt as can be seen it has little salt content. However, they are one of the factors that influence the development of microorganisms, the values that can be seen are presented at the five sampling points.

**CHEMICAL FACTORS OF THE UTCUBAMBA RIVER**

- **DISSOLVED OXYGEN (O.D.) in % and ml**

| **SAMPLING POINT** | 16-Jul-23 | 24-Set-23 | 1-Oct-23 |
|---|---|---|---|
| B.G. BRIDGE | 31.8 | 146.6 | 121.9 |
| TRAYECT 1 | 29.9 | 167.8 | 130.4 |
| BAGUA CHIC | 39.9 | 63.1 | 139.7 |
| MIRACLES 1 | 16.2 | 58.5 | 128.9 |
| MIRACLES 2 | 27.6 | 50.4 | 119.2 |

Analysis of variance of an O.D. factor in %

SUMMARY

| *Groups* | *Account* | *Sum* | *Average* | *Variance* |
|---|---|---|---|---|
| 16-Jul-23 | 5 | 145.4 | 29.08 | 73.307 |
| 24-Set-23 | 5 | 486.4 | 97.28 | 3068.857 |
| 1-Oct-23 | 5 | 640.1 | 128.02 | 64.527 |

ANALYSIS OF VARIANCE

| *Origin of the variations* | *Sum of squares* | *Degrees of freedom* | *Average of squares* | *F* | *Probability* |
|---|---|---|---|---|---|
| Between groups | 25642.185 | 2 | 12821.09272 | 11.994694 | 0.0013741 |
| Within the groups | 12826.764 | 12 | 1068.897 | | |
| Total | 38468.949 | 14 | | | |

Analysis of variance of a factor

SUMMARY

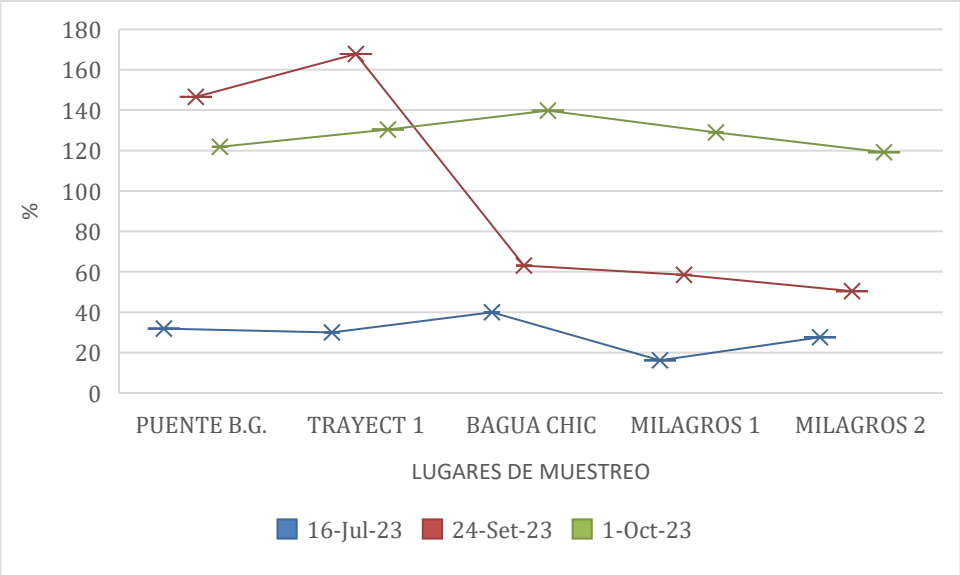
| *Groups* | *Account* | *Sum* | *Average* | *Variance* |
|---|---|---|---|---|
| 45123 | 5 | 15.91 | 3.182 | 0.67572 |
| 45193 | 5 | 37.94 | 7.588 | 19.06767 |
| 45200 | 5 | 43.29 | 8.658 | 1.19407 |

ANALYSIS OF VARIANCE

| *Origin of the variations* | *Sum of squares* | *Degrees of freedom* | *Average of squares* | *F* | *Probability* | *Critical value for F* |
|---|---|---|---|---|---|---|
| Between groups | 84.24052 | 2 | 42.12026 | 6.035153266 | 0.0153531 | 3.8852938 |
| Within the groups | 83.74984 | 12 | 6.97915333 | | | |

| | | |
|---|---|---|
| Total | 167.99036 | 14 |

Figure 6. Chemical parameters Dissolved Oxygen (O.D.) . In original language: Spanish




In Graph 6. The behavior of the O.D. content in water expressed in % is appreciated. The results of the maximum values are 167.8% found in the place Trayecto 1 on September 24 and the lowest was found of 16.2% registered in the District of Milagros 1, carried out in the five study sites that are within the indicators of ECAs that exist O.D. for the life of microorganisms in the aquatic environment.

**DISSOLVED OXYGEN (O.D. in ml/L)**

| **SAMPLING POINT** | 16-Jul-23 | 24-Set-23 | 1-Oct-23 |
|---|---|---|---|
| B.G. BRIDGE | 2.54 | 11.93 | 8.95 |
| TRAYECT 1 | 2.3 | 12.76 | 8.69 |
| BAGUA CHIC | 3.2 | 4.88 | 9.6 |
| MIRACLES 1 | 4.37 | 4.48 | 9.25 |
| MIRACLES 2 | 3.5 | 3.89 | 6.8 |

Analysis of variance of a factor

SUMMARY

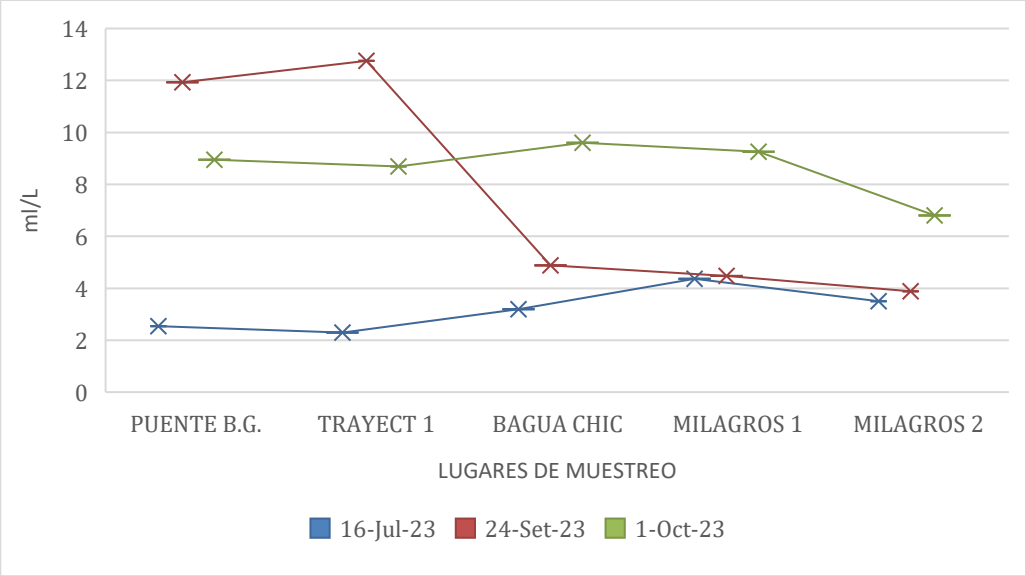
| *Groups* | *Account* | *Sum* | *Average* | *Variance* |
|---|---|---|---|---|
| 45123 | 5 | 15.91 | 3.182 | 0.67572 |
| 45193 | 5 | 37.94 | 7.588 | 19.06767 |
| 45200 | 5 | 43.29 | 8.658 | 1.19407 |

ANALYSIS OF VARIANCE

| *Origin of the variations* | *Sum of squares* | *Degrees of freedom* | *Average of squares* | *F* | *Probability* | *Critical value for F* |
|---|---|---|---|---|---|---|
| Between groups | 84.24052 | 2 | 42.12026 | 6.0351532 | 0.0153531 | 3.8852938 |

| | | | |
|---|---|---|---|
| Within the groups | 83.74984 | 12 | 6.97915333 |
| Total | 167.99036 | 14 | |

Figure 7. CHEMICAL PARAMETER in ml/L. In original language: Spanish




In Graph 7. The behavior of the dissolved oxygen content O.D. expressed in ml/L is appreciated. The results of the maximum values are 12.76 ml/L found in the Route 1 site on September 24 and the lowest was found to be 2.3 ml/L recorded in Route 1, carried out in the five study sites, which is also within ECAs of optimal condition for the life of microorganisms.

**MICROBIOLOGICAL PARAMETERS**

Summary Table of the Occurrence of Microorganisms from Collection Points

FREE-LIVING MICROBIOLOGICAL ANALYSIS

| **SAMPLING POINTS** | **Group: Scianoficeas** | **Group: Protozoa** | **Group: Started** | **Group: Metazoans** |
|---|---|---|---|---|
| 1. B.G. BRIDGE | Spirulina, | Vorticella, Paramecium, | Euglena, Cosmarium, Diatomeas, | Daphnia, |
| 2. TRAYECT 1 | ------ | Paramecium, Amoeba | Cosmarium, | Daphnia, Rotiferos, |
| 3. BAGUA CHIC | ------ | Paramecium, | Euglena | Daphnia |
| 4. MILAGROS 1 | ------ | Amoeba, Vorticella | Euglena, Cosmarium | Daphnia |
| 5. MILAGROS 2 | Nostoc sp, Oscillatoria | Tetrahymen | Zygnema sp, Diatomeas | Daphnia |

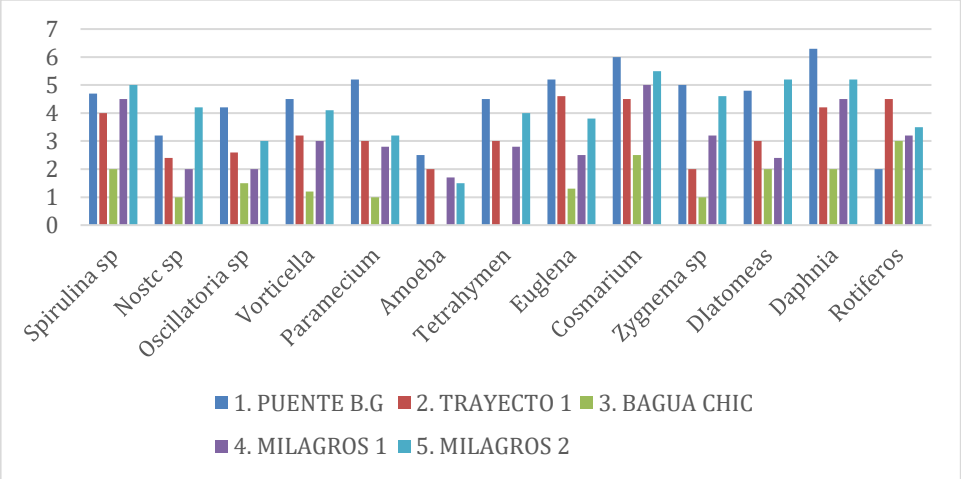
BOX-PLOT type graphs that have the microorganisms on the X-axis and the Y-axis or microorganism count values. Five BOX-PLOT type graphs will be generated, one for each study point.

| AVERAGE SAMPLING AT THE DIFFERENT SAMPLING POINTS | | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| SAMPLING POINT | Spirulina sp | Nostc sp | Oscillatoria sp | Vorticella | Paramecium | Amoeba | Tetrahymen | Euglena | Cosmarium | Zygnema sp | Diatoms | Daphnia | Rotifiers |

| | | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 1. B.G. BRIDGE | 4.7 | 3.2 | 4.2 | 4.5 | 5.2 | 2.5 | 4.5 | 5.2 | 6 | 5 | 4.8 | 6.3 | 2 |
| 2. PATH 1 | 4 | 2.4 | 2.6 | 3.2 | 3 | 2 | 3 | 4.6 | 4.5 | 2 | 3 | 4.2 | 4.5 |
| 3. BAGUA CHIC | 2 | 1 | 1.5 | 1.2 | 1 | 0 | 0 | 1.3 | 2.5 | 1 | 2 | 2 | 3 |
| 4. MILAGROS 1 | 4.5 | 2 | 2 | 3 | 2.8 | 1.7 | 2.8 | 2.5 | 5 | 3.2 | 2.4 | 4.5 | 3.2 |
| 5. MILAGROS 2 | 5 | 4.2 | 3 | 4.1 | 3.2 | 1.5 | 4 | 3.8 | 5.5 | 4.6 | 5.2 | 5.2 | 3.5 |

| SUMMARY | | | | | | |
|---|---|---|---|---|---|---|
| *Groups* | *Account* | *Sum* | *Average* | *Variance* | | |
| Spirulina sp | 5 | 20.2 | 4.04 | 1.433 | | |
| Nostc sp | 5 | 12.8 | 2.56 | 1.468 | | |
| Oscillatoria sp | 5 | 13.3 | 2.66 | 1.068 | | |
| Vorticella | 5 | 16 | 3.2 | 1.635 | | |
| Paramecium | 5 | 15.2 | 3.04 | 2.228 | | |
| Amoeba | 5 | 7.7 | 1.54 | 0.883 | | |
| Tetrahymen | 5 | 14.3 | 2.86 | 3.048 | | |
| Euglena | 5 | 17.4 | 3.48 | 2.507 | | |
| Cosmarium | 5 | 23.5 | 4.7 | 1.825 | | |
| Zygnema sp | 5 | 15.8 | 3.16 | 2.868 | | |
| Diatoms | 5 | 17.4 | 3.48 | 2.072 | | |
| Daphnia | 5 | 22.2 | 4.44 | 2.513 | | |
| Rotifiers | 5 | 16.2 | 3.24 | 0.813 | | |
| | | | | | | |
| ANALYSIS OF VARIANCE | | | | | | |
| *Origin of the variations* | *Sum of squares* | *Degrees of freedom* | *Average of squares* | *F* | *Probability* | *Critical value for F* |
| Between groups | 41.0098462 | 12 | 3.41748718 | 1.82370729 | 0.06833683 | 1.94361695 |
| Within the groups | 97.444 | 52 | 1.87392308 | | | |
| Total | 138.453846 | 64 | | | | |

Figure 8. FREE-LIVING ORGANISMS . In original language: Spanish




In Graph 8. The behavior of free-living microorganisms is expressed represented in numerical units that by means of a pipette one or more drops of water are established on a slide taken at the five sampling points, finding the largest quantity is the species Daphnia, Cosmarium and Paramecio found in the places bridge Bagua grande and district of miracles 2, which are free-living species that adapt to an aquatic environment, which means that there is a process of extinction in an aquatic environment, they have a broad relationship with physical and chemical parameters.

**DISCUSSIONS**

In the analysis of the results at the different points and dates of sampling obtained, which, they indicate are with optimal values according to Environmental Quality Standards (ECAs) for Water, reference comparisons are made called conservation of the aquatic environment-river of the jungle according to D.S. No. 004-2017-MINAN that is between pH 6.5 – 9.0. According to ANA (2013), pH values fluctuate between 6.37 and 8.8, observing that in two (02) sampling points they are outside the range established for category 4 (6.5-8.5) in the monitored points in the Ica River basin. for a temperature expressed Δ 3: means a variation of 3 degrees Celsius with respect to the multiannual monthly average of the area evaluated. However, in the study of the Utcubamba River the pH is between 7.45-8.93 and the temperature is between 21-6-27.7°C, for E.C. it is established 1000 mmhos/cm and in the study it fluctuates 139.2-490 mmhos/cm, for TDS < 400 mg/L, in the study it is between 97.3-342 mg/L and for Salinity 0.5 expressed (ppt). in the study between 0.0.2 (ppt). In the chemical parameters of the O.D. it fluctuates between 16.2-39.9% on July 16, 50.4-167.8% on September 24 and between 119.2-139.7% on October 1 and in the free life of the microorganisms in the 5 sampling points there is a variety of different microorganisms of free aquatic life, which contrasts with the values of the study are within the parameters of the ECAs, therefore, in physical, chemical and microbiological factors that are found in a body of water guarantee the life of living beings. However, (Custodio & Pantoja, 2012). In the Cunas Colombia River, the results showed that the maximum pH was 8.37 and the lowest was 8.04, the maximum electrical conductivity was 450 uS/cm and the minimum was 430 uS/cm, the temperature fluctuated with a maximum of 14.8 °C and a minimum of 11.8 °C, for total dissolved solids its maximum value was 315 and its minimum was 301 mg/l. Likewise, (Javier, 2003) indicate contamination in the micro-basin of the La Soledad River, Valle de Ángeles, Honduras; the parameters show a maximum temperature that was 27.75 °C and a minimum of 19.25 °C, the pH comprises between 3.19 and 7.97 pH units as a minimum and maximum in such a way that there is no significant deterioration of water quality and they are established within the parameters of the ECAs. However, Alarcón et al., (2023) report Dissolved Oxygen in water: its concentration is related to oxidability, especially with the content of biodegradable organic matter. It varies between 0 and 25. And with the authors mentioned they have a certain relationship with the study carried out on the Utcubamba River.

**CONCLUSIONS**

In the environmental parameters, the following conclusions are reached: in the pH, the maximum value was found in the Utcubamba River of the Dist Milagros1 with a pH of 8.93, which indicates slightly alkaline that it is not within the optimal parameters of water ECAs for rivers that is recorded on September 24 and the minimum value was recorded of a pH 7.45 on July 16, which indicates that the pH is slightly optimal for the consumption of water of living beings being in the place of the Puente de Bagua Grande, in the temperature

the highest value is 27.7°C that is recorded on the date of December 3 being in the place Bagua Chica and of lower T° is 21.5°C obtaining on the date October 1 in the river place Dist Milagros 2. C.E. the highest value is 490 mmhos/cm which was recorded on July 16 in the Bagua Chica place and the minimum value is 139.2 mmhos/cm being recorded on December 3 in the place Puente Bagua Grande, in TDS the highest value is 342 mg/l is estimated on July 16 in the Bagua Chica place and the lowest value is 97.3 mg/l being found on December 3 in the Bagua Grande place and in Salinity are estimated from 0.00 to 0.2 g/l, these results were found in the 05 sampling points. The values of C.E., TDS and Salinity are within the optimal parameters of the ECAs of the waters of the Utcubamba River; which indicates that the consumption of water by the living beings of the Utcubamba River is suitable. However, in the analysis of variance of the environmental parameters for the 05 sampling sites in the interpretation in Rows there is no significant difference, therefore, the hypothesis is accepted and for columns there is a highly significant difference, therefore, the null hypothesis is rejected. In relation to the determination of microorganisms, the species that stand out are the following: In the *Scianoficeae Group: Spirulina Sp, Nostoc sp* and *Oscillatoria* that were found in the Puente Bagua Grande and Milagros 2 places. In the Protozoa Group: *Vorticella, Paramecium, Amoeba and Tetragimen*, it was found in the 05 sampling points. In the Algae Group: *Euglena, Cosmarium*, *Diatomaceous*, it was found in the 04 sampling sites and the *Zygname,* was found in the Milagros 2 site. In Metazoan Group: the species *Daphnia* was found in the 04 sampling sites, except *for Rotiferos and Daphnia* was found in Route 1. *Chlorophyta Group:* found at the Puente Bagua Grande, Trayecto 1 and Bagua Chica sampling points.

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