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PHYSICAL PROPERTIES, CORRELATION AND REGRESSION ANALYSES OF POTABLE WATER IN ILORIN, NIGERIA

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ABSTRACT

Water is said to be wholesome if it is fit to use for drinking, cooking, food preparation or washing without any potential danger to human health. This research aimed to determine the potability of water from borehole, sachet and river in Ilorin, Nigeria using physical parameters, assess the correlation between the parameters and carry out regression analysis of the parameters. Water samples were randomly collected from the three Local Government Areas (LGA) in Ilorin to assess physical properties and carry out correlation and regression analyses. Temperature of water samples were between 29 °C – 31.4 °C while pH ranged between 6.42 and 7.90. Correlation coefficient was +0.989 while regression analysis estimated optimal temperature of 30 °C for pH of 7.03. The physical parameters of water in the study area fell within recommended range. There was strong direct relationship between the physical parameters studied. Further studies could consider investigating other physical and chemical parameters involving larger number of samples.

Keywords: Potable water, physical parameters, correlation, regression, Ilorin

INTRODUCTION

Water has been identified as a necessity to life (Falkenmark, 2020)). Good quality water and its availability help to promote and maintain life and is necessary for the sustenance of growth and development (Ugwu *et al*., 2016; Palmer *et al*., 2018). Drinking water quality has often been adulterated owing to several anthropogenic factors which render it unfit for drinking (WHO, 2020). For water to be of good quality, it must be tasteless, odourless, colourless and devoid of faecal pollution (WHO, 2015).

In sub-Saharan Africa alone, up to 300 million rural people have no access to safe water supplies. Without safe water near dwellings, the health and livelihood of families can be severely affected (Hope *et al*., 2020). Groundwater exploitation is generally considered as the major realistic option for meeting dispersed rural water demand (UN, 2019). Due to the inability of governments to meet the ever-increasing water demand, people resorted to groundwater sources such as shallow wells and boreholes as alternative water sources (Ugwu *et al*., 2016). Studies on groundwater have been carried out in different parts of Nigeria (Egereonu, 2003; Okeke and Igboanua, 2003; Aiyesanmi *et al*., 2004; MacDonald *et al*., 2005; Adekunle *et al*., 2007; Idoko, 2010).

Sachet water is the most affordable type of drinking water in use in most developing countries (Oludairo and Aiyedun, 2015). This is because the affordability of standard industrialized world model for delivering reliable drinking water and sanitation technology in most of the developing world is still low, some people therefore, resort to water sources of doubtful quality so as to meet their need (Dada, 2009). Factors such as source, level of purification and the handling of water may introduce hazard and constitute threat to life (WHO, 2015). River is another important source of drinking water in developing countries and is of particular importance in the study of surface water pollution because effluents from small industries, municipal sewage, agricultural and urban run-off are discharged into it bringing about considerable change in the water quality (WWAP/UN-Water, 2018). Most towns in Nigeria with rivers passing through them have converted such rivers into dump sites, latrines and channels where solid wastes are discharged without any form of pre-treatment with the consequence adverse effects on the health of downstream users and environmental sanitation deterioration (Ferronato and Torretta, 2019). Rivers play a major role in the assimilation or transportation of municipal and industrial wastewater and runoff from agricultural and mining land (Ferronato and Torretta, 2019). Furthermore, rivers are dynamic systems and may change in nature several times during their course because of changes in physical conditions such as slope and bedrock geology (Oludairo and Aiyedun, 2015). However, some people still use water from the river for domestic and recreation purposes (Ugwu *et al*., 2016).The public health issues arising from the multipurpose usage of water from spring and stream by local residents thus hinge majorly, on the self-purification capacity of the river and stream (Afiukwa and Eboatu, 2013, Hope, 2020). River water quality monitoring is necessary especially where the water serves as drinking water sources and are threatened by pollution resulting from various human activities along the river course (Ferronato and Torretta, 2019).

Many diseases are associated with contaminated water and water shortages (Pal *et al.,* 2018). Different investigators have studied water quality parameters in various locations in Nigeria (Onwughara *et al*., 2013; Yusuf *et al*., 2015; Ugwu *et al*., 2016). In Ilorin metropolis, the most affordable type of drinking water used is sachet water, river water and stream water while borehole is used by the upper echelons of the society.

The focus of this study is to determine the potability of common drinking water sources in the metropolis by assessing the level of physical parameters which are indicators of the quality of water, to investigate the correlation between these parameters and carry out regression analysis. The results of the study will also serve as baseline data for water quality study in the three LGAs in Ilorin in the future.

MATERIALS AND METHODS

Study Area

Ilorin metropolis is located in Kwara State, North-central Nigeria. It lies between Longitude 8°05′ and 10°15′ N; and Latitude 2°73′ and 6°13′ E. It has three LGAs. The major sources of employment are agriculture and cottage industries, which engage almost 80% of the workforce.

Sample Collection and Procedure

Purposive sampling method was adopted for the study. Borehole, sachet and river water were obtained from various points in Ilorin metropolis to cover Ilorin South, Ilorin East and Ilorin West LGAs which were the three council areas in the city. River water samples were taken from the surface of the river, sachet water were obtained from selling points while borehole water samples were gotten from boreholes in the city. A total of 87 water samples were collected. Collections were done in sterile McCartney bottles, placed in ice-packed flasks and immediately transferred to the Food Safety Laboratory of the University of Ilorin for analysis. The temperature and pH of the water samples were examined using the Mettler microprocessor pH portable meter. The analysis of the water samples were done in accordance with standard methods and manufacture's instruction (WHO, 1984a, WHO, 1984b; Fresenius *et al*., 1988; APHA, 1992; DPR, 2000; NIS, 2003). The pH meter was first standardized with buffer solutions of pH 4, 7 and 9. The pH of the water samples were then determined by inserting the electrode of the meter into each water sample, values were read and recorded when the meter indicator became stable. Measurement of temperature of the water samples were carried out in the laboratory using the in-built pH meter mobile digital thermometer. This was done by dipping the thermometer into the sample and recording the stable reading. Correlation and regression analysis of the water parameters were done using Microsoft Excel® 2013 and Nlcula sample correlation coefficient/linear regression statistics calculator® 2017.

RESULTS

Nineteen water samples each were collected from Ilorin South, Ilorin East and Ilorin West LGAs while 49 were collected from Ilorin West LGA. Sixty of the samples were obtained from boreholes while 20 and 7 were from sachet water and river respectively (Table 1). The breakdown of the samples collected from borehole, sachet water and river from the three LGAs in the metropolis are as presented in Table 1. The temperature of water samples ranged from 29 ^{0}C to 31.4 ^{0}C while pH ranged from 6.42 to 7.90. The Pearson correlation coefficient (r) for the recorded temperatures and pH was +0.989 (Table 2). The scatter plot for the correlation coefficient is as shown in Figure 1. The regression analysis yielded y=0.61140973630825x-11.309954361053. The estimated values of pH while temperature is 20 ^{0}C, 25 ^{0}C, 30 ^{0}C, 35 ^{0}C, 40 ^{0}C and 45 ^{0}C are 0.92, 3.98, 7.03, 10.09, 13.15 and 16.30 respectively (Table 2).

Table 1: Distribution of water samples from the three Local Government Areas in Ilorin, Nigeria

		Local Government Area			
Serial Number	**Source of water**	**Ilorin South**	**Ilorin East**	**Ilorin West**	**Total number**
1	Borehole	7	11	42	60
2	Sachet water	12	8	0	20
3	River	0	0	7	7
Total		19	19	49	87

Table 2: The temperature and pH of water samples in Ilorin, Nigeria

Local Government Area	Number of water samples tested (n)	Minimum temperature (°C)	Minimum pH	Pearson correlation coefficient for temperature and pH (r)	Projected temperature of water (°C)	Corresponding pH using Regression line equation
Ilorin West	49 (N=87)	29.00	6.42	+0.989	20	0.92
Ilorin East	19 (N=87)	29.30	6.65		25	3.98
Ilorin South	19 (N=87)	29.30	6.53		30	7.03
Ilorin West	49 (N=87)	31.40	7.90		35	10.09
Ilorin East	19 (N=87)	31.00	7.80		40	13.15
Ilorin South	19 (N=87)	31.40	7.75		45	16.30

Regression line equation: y=0.61140973630825x-11.309954361053

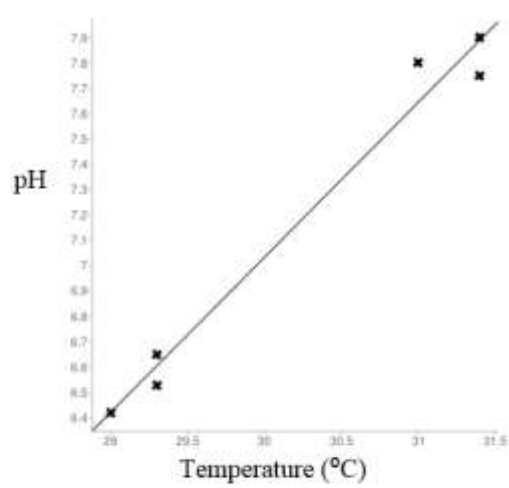

Figure I: Correlation coefficient scatter plot for the temperature and pH of water samples from Ilorin, Nigeria

DISCUSSION

The skewness of the collected samples to borehole water samples and river water to Ilorin West LGA may be due to the proximity of these sources of water to the researcher and natural endowment of the area respectively. In addition, the purposive method employed in this study could also be a contributory factor.

The recommended pH of potable water is in the range of 6.5 and 8.5. Most of the water samples fell within the range except for some sample that were slightly below it. This is similar to the results obtained by Ugwu *et al* (2016). The pH of water is a measure of acidity and alkalinity. The pH ranges between 0-14 with 7 as the neutrality level. A water pH of less than 7 indicates the acidity of that water sample while a pH exceeding 7 implies that the water is alkaline (WHO, 1998; NIS, 2003). Alkaline water has been documented to be better than acidic water. Wynn *et al* (2009) observed that minerals like calcium can be 30% easier to be absorbed by the body from water than from food. If water is alkaline, healthy minerals may be obtained from it while if it is acidic toxins like mercury can be absorbed from it (Wynn *et al* 2009). Mild acidic increase in water samples increased the capacity of water to attack geological materials and leach toxic trace metals into the water where present. Adjustment of the pH of water could be achieved by the addition of alkaline and acidic reagents (Wynn *et al* 2009).

The temperature of water refers to the measure of its hotness or coldness. The recommended temperature for potable water is ambient temperature which was between 31 ^{0}C and 32 ^{0}C at the study area. All the water samples had temperatures either within this range or lower. This could be partly due to the timing of collection of samples which were done early in the morning or because sachet water and other samples were placed on ice packs for transportation to the Laboratory before the analysis.

The values of temperature obtained for water samples are similar to those reported by Obi and Okocha (2007) and Chukwu (2008). Cool waters are generally more potable for drinking purposes, because high water temperature enhances the growth of micro-organisms thereby increasing taste, odour, colour and corrosion challenges (Okoye and Okoye, 2008). Metal corrosion is also associated with high temperature especially when the pH of the water is acidic.

The correlation between temperature and pH of water samples in the study area was strong and positive. Direct relationship implies increase in temperature results in increase pH while decrease in temperature may also lead to decrease in pH. Slight increase in temperature and pH may favour the growth of some microorganisms and make water unfit for human consumption.

Regression analysis which enabled the estimation of the values of pH at certain temperatures based on the relationship between the two variables revealed that water temperature of about 30 ^{0}C will have estimated pH of 7.03 while the pH of water at lower and higher temperature will result in acidic or alkaline water which may not be wholesome for consumption.
Further studies on physico-chemical parameters and evaluation of heavy metals in potable water in the study area could be carried out.

CONCLUSION

Borehole, sachet and river water within Ilorin metropolis had temperatures and pH that fell between internationally recommended range. Direct strong relationship was established between these two physical parameters. Projected low temperatures yielded low pH while high temperatures yielded high pH. Optimal temperature of 30 ^{o}C yielded pH of 7.03.

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