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COMPARISON OF pH VALUES IN SELECTED WATER TREATMENT PLANTS OF PLATEAU STATE.

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ABSTRACT

Investigation for comparison of pH values in three water treatment plants of Plateau State Water Board is carried out in this research work. The aim is to ascertain whether all Plateau State residents receive the same range of water pH values in their drinking water. Main analyses are also centred on determining whether there is statistical significant difference in the acidity or alkalinity of drinking water in the selected water treatment plants. Shapiro-Wilk test shows that the data follows normal distribution and the application of the Levene's test shows that the validity of homogeneous assumption holds. One Way ANOVA confirms that the difference between monthly pH values of the three selected water treatment plants are statistically significant. To be sure, we applied non-parametric independent Kruskal-Wallis test since the sample size is small and the assumption of normality and homogeneity of variances are not required. The p-value obtained is 0.001 at

Introduction:

Chemical measurement is very important in water treatment plants to reduce negative effects of excessive chemical constituents in human body. Plateau State being one of the states in Nigeria established Plateau State Water Board(PSWB). This water board is in charge of water treatment and distribution in the state and also formed dams with various treatment plants to treat raw water before being distributed to the various homes of its residents.

The measure of degree of acidity or alkalinity of water is pH. The earth's crust is generally alkaline in nature and the water bodies are most often found

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0.05 significance level hence there is statistical significant difference in the pH of the three water treatment plants. This result agrees very well with that of One-Way ANOVA. The Tukey-Kramer test and its homogeneous subsets for monthly pH value of the three water treatment plants confirm that water treatment 1 and water treatment 2 are significantly different in monthly pH values from water treatment 3. The mean plots for the three water treatment plants shows that treatment 3 has highest mean pH value compared to the other two.

Keywords*: pH values, water treatment, acidity, alkalinity, disinfectant, Water Board, Plateau state.*

On the earth crust thus water is mostly found to be alkaline in its raw form and optimum agricultural production depends on water and soil quality (Jagadeesh *et.al,2012*). There is need to treat water and its pH correct to the World Health Organization(W.H.O) standard which is in the range 6.5-8.5 (W.H.O, 1998).

Mineralogy and solubility of rock forming minerals can alter the pH values and may strongly influence the nature and amount of dissolved species in natural water (Raymahasay, 1996).

One of the most common water quality tests performed is pH test; It is an indication of acidity and alkalinity present and actually measures potential activity of hydrogen ions(H+) in the sample. Due to change in physico-chemical conditions, the higher pH values observed in some samples indicate that carbon dioxide, carbonate-bicarbonate equilibrium is affected more.(Karanth, 1987; Tiwari et al. 2009).

By measuring the extent of ecological upset, the severity of pollution can be estimated(Swaranlatha and Narsingrao, 1998). Bacterial contamination in rivers does not have much influence on the biological water quality of rivers as indicated by the results obtained in (Semwal, 2006). Usually, pH test runs on a scale from 0 to 14 , with 7 considered neutral. Values between 0 – 7 are acidic while values above 7 is alkaline. Human beings and other living things function best within a given range of pH.(Rose, 1986). Health effects are most pronounced in pH above 11 while irritation

due to the corrosive effects of low pH values below 4 is also common. Due to use of contaminated drinking water, human population suffers from various water borne diseases. (Basavaraja, et al., 2011)

This study aims to determine whether all Plateau state citizens receive same range of water pH value in their drinking water. With rapid increase in the population of Plateau state there is a growing need for potable water. This study also intends to compare the means of the pH in the three selected water treatment plants.

MATERIALS AND METHODS

The data for the study was extracted from monthly records of pH values for the year 2015 which is the most detailed of all the recorded yearly data available. This was obtained from three selected water treatment plants of Plateau State Water Board. Descriptive statistics, Welch ANOVA and Games-Howell tests are used for the analysis.

Research hypothesis:

H_0: There is no significant difference between pH values of the three selected water treatment plants.

H_1: There is significant difference between pH values of the three selected water treatment plants.

RESULTS

The Shapiro-Wilk test has the p-value 0.061 while Kolmogorov-Smirnov test has p-value 0.003 which means that the two conducted tests do not agree. Since the sample size is small as data for 12 months was analysed and One-Way Analysis of Variance (ANOVA) is robust to the test of normality to some extent, it is safer to agree with Shapiro-Wilk test of normality thus the raw data follows normal distribution.

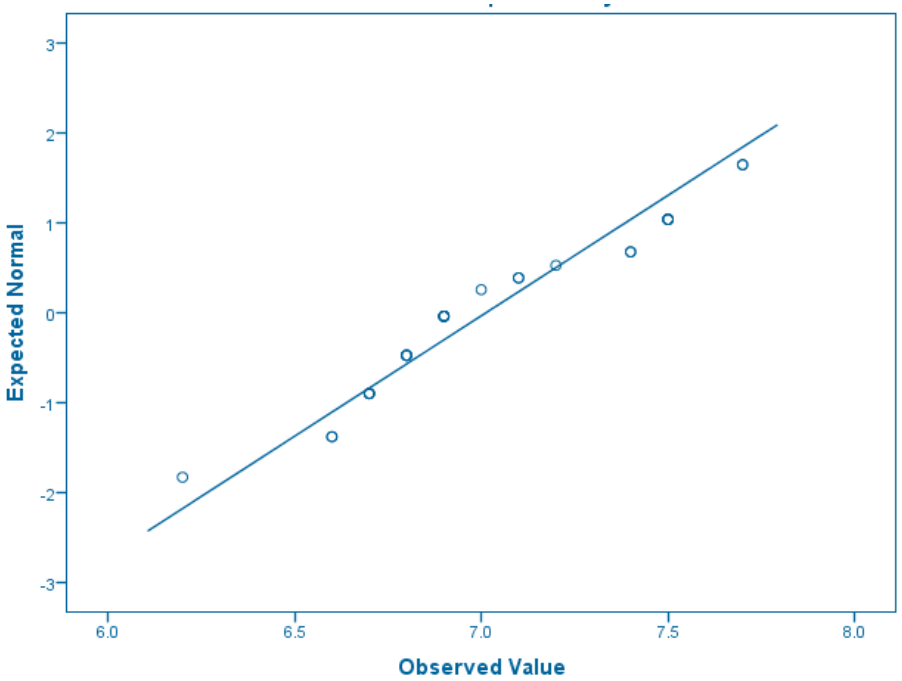

Figure 1: Normal Q-Q Plot of the Monthly Data Structure of pH values in Three Water Treatment Plants of PSWB (2015)

The descriptive statistics of the average monthly pH for the three water treatment plants is shown in the table below:

Table 1: Descriptive Statistics of Monthly pH of Three Water Treatment Plants of PSWB(2015)

	N	Mean	Standard eviation	Standard Error	95% Confidence Interval for Mean		Minimum	Maximum
					LBound	UBound		
1	11	6.7545	0.22962	0.6923	6.6003	6.9088	6.20	7.10
2	9	6.9556	0.31667	0.10556	6.7121	7.1990	6.60	7.70
3	9	7.3889	0.25712	0.08571	7.1912	7.5865	6.80	7.70
Total	29	7.0138	0.37295	0.06925	6.8719	7.1557	6.20	7.70

From Table1 above, water treatment plant2 has the highest standard deviation with the value 0.31667 while water treatment plant1 has the lowest standard deviation with the value 0.22962. The standard deviations of pH values for the three water treatment plants do not differ

considerably which is a good signal concerning the requirements of classical ANOVA.

Using Levene's test, the result for the monthly pH data is shown in the table below:

Table 2: Levene's Statistics for Monthly pH for Three Water Treatment Plants

Levene Statistics	df1	df2	Sig
0.170	2	26	0.844

From Table 2 above, the result shows the test of homogeneity and it confirms that the assumption of homogenous variance hold. This claim satisfies one of the requirements of classical one-way ANOVA.

The result for one-way ANOVA test is shown in the table below:

Table 3: One Way ANOVA for Monthly pH Values of Three Water Treatment Plants

	Sum of Squares	df	Mean Square	F	Sig.
Between Groups	2.036	2	1.018	14.243	.000
Within Groups	1.858	26	0.071		
Total	3.894	28			

From Table 3 above, the calculated F test value is greater than the value in F distribution table. It is also obvious that the significance value in the ANOVA table above is less than 0.001. Based on the fact that the calculated result is greater than the table results, we reject the null hypothesis. Now that we know that there is statistical significant difference between the monthly pH values of the three selected water treatment plants, we proceed to learn about the structure of the differences.

From the One-way ANOVA table, since there is significant difference between monthly pH value of the three water treatment plants, there is need to employ post hoc test to learn about the structure of the differences.

Since all pairwise comparisons are made and the assumption of homogeneity of variance hold, we employ the Tukey-Kramer test. Thus, the Tukey-Kramer test is shown in the table below:

Table 5: Tukey-Kramer Test for Monthly pH values of Three Water Treatment Plants

i Numbers Monthly	j Numbers Monthly	Mean Difference (i – j)	Std Error	Sig.	95% Confidence Interval for Mean	
					LBound	UBound
1	2	-0.20101	0.12017	0.235	-0.4996	0.0976
	3	-0.63434	0.12017	0.000	-0.9329	-0.3357
2	1	0.20101	0.12017	0.235	-0.0976	0.4996
	3	-0.43333	0.12603	0.005	-0.7465	-0.1202
3	1	0.63434	0.12017	0.000	-0.3357	0.9329
	2	0.43333	0.12603	0.005	0.1202	0.7465

From the table 5 above, comparison between water treatment1 and water treatment3 with absolute mean difference 0.63434 shows highest significant difference in the values of pH. Also treatment2 and treatment3 have statistically significant values of pH with absolute mean difference 0.43333 while water treatment1 and water treatment2 does not show any significant difference in the values of pH.

Table 6: Tukey-Kramer homogeneous subset for Monthly pH value of Three Water Treatment plants

	j Numbers Monthly	N	Subset for alpha = 0.05	
			1	2
Turkey[a,b] HSD	1	11	6.7545	
	2	9	6.9556	
	3	9		7.3889
	Sig.		0.245	1.000

a. Uses Harmonic Mean Sample Size = 9.581.

b. The group sizes are unequal. The harmonic mean of the group sizes is used. Type I error levels are not guaranteed.

Homogeneous subsets from Tukey- Kramer test confirms that water treatment1 and water treatment2 are statistically significantly different in monthly pH values from water treatment3 as shown in Table 6 above.

The mean plot for the three water treatment plants is shown in the figure below:

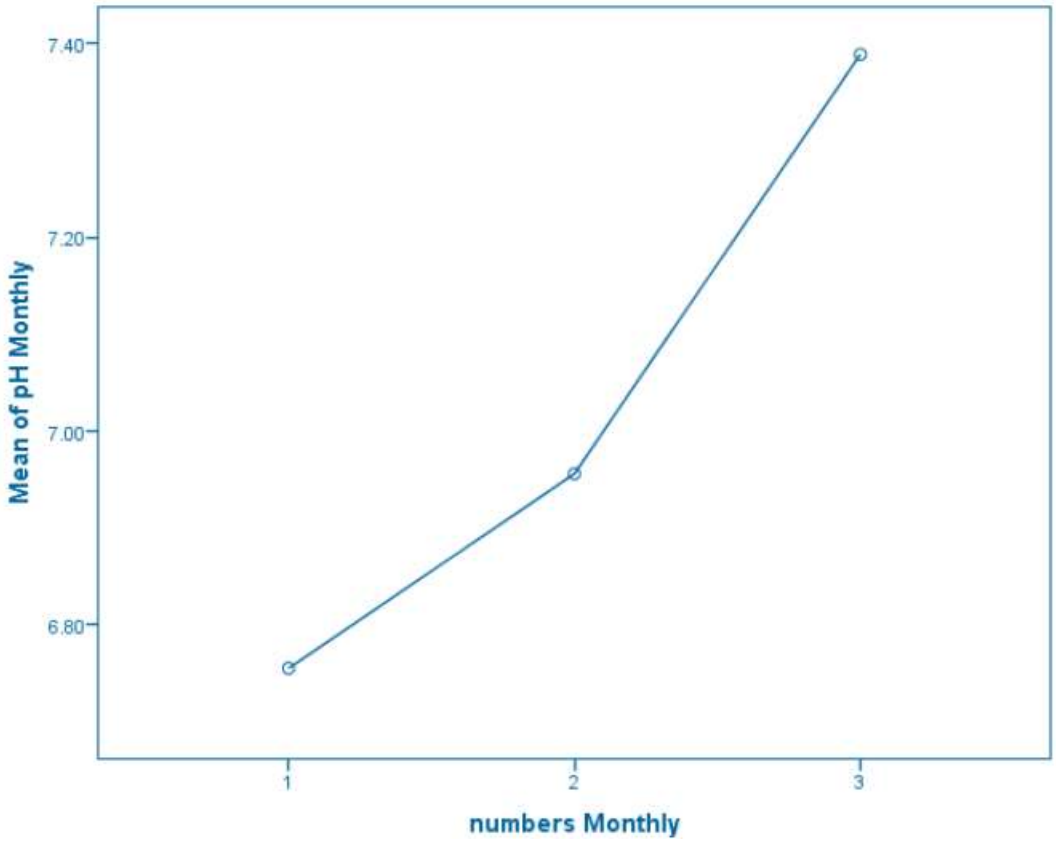

Figure 2: Mean Plots of pH values in Three Water Treatment Plants of PSWB (2015)

We apply non-parametric independent Kruskal-Wallis test since the sample size is small and the assumption of normality and homogeneity of variances are not required. The p-value obtained is 0.001 at 0.05 significance level hence the rejection of null hypothesis. There is statistical

significant difference in the pH of the three water treatment plants. This result agrees very well with that of One-Way ANOVA.

DISCUSSION

Due to small sample size we follow the Shapiro-Wilk test which has the p-value 0.061 shows that the data is normally distributed. The descriptive statistics displays that standard deviations of pH values for the three water treatment plants do not differ considerably as shown in Table 1.

Levene's test results confirm that the monthly pH values have homogeneous variances between the groups as depicted in Table 2. The results for one-way ANOVA test as shown in the Table 3 have the calculated F test value greater than the value in F distribution table. Since the significance value in the ANOVA table above is less than 0.001 and the F calculated result is greater than the F tabulated results, we reject the null hypothesis. The structure of the differences in the monthly pH values of the three water treatment plants is obtained using Tukey-Kramer's test. All pairwise comparisons are made on the assumption of homogeneity of variances. Comparison between water treatment1 and water treatment3 with absolute mean difference 0.63434 shows highest statistical significant difference in the values of pH while water treatment1 and water treatment2 does not show any significant difference in the values of pH as shown in Tables 5 and 6.

CONCLUSION

In this research work, we carried out analysis of pH values in three selected water treatment plants of Plateau State Water Board. Using Shapiro-Wilk test, the data follows normal distribution and the Levene's test confirms homogeneity of the variances as valid assumption. The descriptive statistics of the pH data shows that the standard deviation for the three water treatment plants do not differ significantly from each other. One Way ANOVA for Monthly pH Values of Three Water Treatment Plants shows that there is statistically significant difference between the monthly pH values of the three selected water treatment plants.

Thus, the Tukey-Kramer test and its homogeneous subsets for Monthly pH value of Three Water Treatment plants confirm that water treatment1 and water treatment2 are statistically significantly different in monthly pH values from water treatment3. The mean plots for the three water treatment plants shows that treatment3 has highest mean pH value compared to the other two values.

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