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Estimating the amount of chlorine and fluoride in water treatment in Taraba State, Nigeria

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Abstract

Some organisms and chemicals are hazardous to human health if found in drinking water. Drinking water should be free of suspended particles. It must be colourless, odourless and tasteless .In order to achieve the stated qualities of water, water is being treated with chlorine and fluoride in Taraba State. It is clear to us that high concentrations of fluoride (above 1.5 mg/litre, the WHO guideline value) can damage bones and teeth. Chlorine compounds on the other hands destroy pathogens after 30 minutes of contact time. The amount of chlorine that will be needed to kill the pathogens will be affected by the quality of the untreated water and by the strength of the chlorine compound used. The addition of chlorine in excess will do more harms than good to human health and for this reason, we have decided to carry out this research so as to find out if the amount of chlorine and fluoride being added into water for treatment is adequate. Data was collected from Taraba State Water Board. The data covered the whole 2015 that is from January to December, 2015. Water treatment is gone daily, but we selected data for four days in each month at random. Pearson's correlation coefficient and Analysis of Variance methods were used in the analysis. The significance of the correlation coefficient results was tested by the use of student t-distribution test. The results from both Correlation and Analysis of Variance show that the amount of chlorine and fluoride used in water treatment in Taraba State is statistically adequate. Some organisms and chemicals are hazardous to human health if found in drinking water. Drinking water should be free of suspended particles. It must be colourless, odourless and tasteless .In order to achieve the stated qualities of water, water is being treated with chlorine and fluoride in Taraba State. It is clear to us that high concentrations of fluoride (above 1.5 mg/litre, the WHO guideline value) can damage bones and teeth. Chlorine compounds on the other hands destroy pathogens after 30 minutes of contact time. The amount of chlorine that will be needed to kill the pathogens will be affected by the quality of the untreated water and by the strength of the chlorine compound used. The addition of chlorine in excess will do more harms than good to human health and for this reason, we have decided to carry out this research so as to find out if the amount of chlorine and fluoride being added into water for treatment is adequate. Data was collected from Taraba State Water Board. The data covered the whole 2015, that is from January to December, 2015. Water treatment is gone daily, but we selected data for four days in each month at random. Pearson's correlation coefficient and Analysis of Variance methods were used in the analysis. The significance of the correlation coefficient results was tested by the use of student t-distribution test. The results from both Correlation and Analysis of Variance show that the amount of chlorine and fluoride used in water treatment in Taraba State is statistically adequate.

Keywords: Chlorine, Fluoride, Treatment, Correlation, Analysis, Variance.

Introduction

The Encarta Dictionaries defined water as liquid of rain and river; the clear colourless liquid, odourless and tasteless when pure, that occurs as rain, snow and ice, forms rivers, lakes, seas, and is essential for life. Water is simply defined as the free gift of nature[1]. The English dictionary defined water as a clear liquid having the chemical formula H_2O required by all forms of life on earth[2]. Water is the most precious component on earth and more than 70 % of the blue planet's surface is covered by it, making a total volume of 1,36.109 km^3.

Water is used as solvent for nutrients that are taken up by plants, animals and humans. It is used for basic hygiene, recreation and religious purposes[3]. Water is a basic necessity for life. Unfortunately, not all water helps human to survive. Water from contaminated sources causes numerous diseases and untimely deaths. The fact that human being needs water and cannot live without it forces him to use it even for drinking purposes, from any source, whether pure or contaminated, As a result, many people suffer or die from waterborne diseases. Hence, every country has to take preventive measures to avoid pollution and contamination of the available water resources.

Therefore, public water supply must be potable, palatable and wholesome. Water must not have disagreeable physical change and must be hygienically safe[3]. Water is necessary in promoting personal hygiene and in cleaning the environment.

Without an adequate and wholesome water supply, health cannot be maintained. Water is essential for life. Man can live nearly two months without food, but can live only three or four days without water. In general, 70% of human body weight is water and a human being needs two litres of water per day as minimum. Most of the foods that man eats contain water. For example: Milk contains about 88% water. - Egg contains about 66% water. Fish are 80% water. Potatoes are 75% water. Beef is 77% water 4.

It is essential to run industries. Nearly all modern industries are thirsty; they need water. For example: It takes about 10 litres of water to produce one litter of petrol. Also, animal life depends directly or indirectly upon vegetation for food, and vegetation will not grow without water. Bacteria need water in order to thrive. New plants growing in the soil take up nutrients through their roots in the form of a solution in water. Any break in this ecological chain can mean failure of the whole ecological system. Water is important for agriculture, animal breeding and fishing. It is a valuable source of energy that is capable of generating hydroelectric power. Water facilitates transportation and navigation and plays an important role in recreation activities. Pure water consists of two atoms of hydrogen and one atom of oxygen chemically combined[3].

Water has the ability to dissolve solids and to absorb gases and other liquids. Hence, it is often referred to as the "universal solvent". Because of this solvent power, all natural water contains minerals and other substances in solution, which have been picked up from the air, the soil, and the rocks as it flows[3]. The quality of water is determined by many factors such as physical, chemical or biological parameters. The main sources of drinking water are lakes, reservoirs, canal, ground water, sea water, rain water, atmospheric water generation and fog collection that depending on the source of pollutant, their pollution could be different[4-10].

There are several problems that can endanger the quality of the drinking water and some diseases can occur by drinking improperly treated water. It is clear that water is one of the essential substances for living things and it is necessary for human survival on the earth[11-12]. A community's drinking water supply comes from ground and surface water sources. Every country's regulations require communities to treat and disinfect drinking water before distributing it to the public, because of the possible presence of pollutants (microorganisms, toxic minerals and metals, organic chemicals, radioactive substances, additives).

Usually surface water has to undergo many more purification steps than groundwater to become suitable for drinking. Every country has its own legal drinking water standards. These prescribe which substances can be in drinking water and what the maximum concentrations of these substances are. The standards are called maximum contaminant levels. They are formulated for any contaminant that may have adverse effects on human health and each company that prepares drinking water has to follow them up[13]. Water is not absolutely pure in nature. Impurities vary from dissolved gases, chemicals, minerals, to suspended matter and disease-causing micro-organisms. Some can be seen with the naked eye, while others that cannot be seen are detected by taste or smell or other laboratory methods. Water gathers impurities as it goes through its natural cycle[3]. According to WHO survey, 80% of all illnesses in developing countries are water-associated.

The use of unsafe water causes high prevalence of diarrhoeal diseases among children resulting in high infant and child mortality rates[14]. Water as the basic necessity for life, harbour diseases which are harmful to life, if not properly treated. This then created the desire for this study so as to find out if the chemicals used in the treatment of water in Taraba State is adequate because ill-treated water creates more harm than good in human life and this problem if not solved can lead to loss of resources and lives.

The Government of Taraba State knows that water carries a lot of impurities as it flows and so it is treated with chemicals, so as to remove the impurities from it thereby making it fit for human consumption. S.T. Sanamdikar and K.R. Harne observed that water treatment is not as easy as it seems and it has great importance in industries as well as in the society[15]. S. Vigneswaran and M. Sundaravadivel et al observed that conventional waste treatment technologies improve the quality of waste discharged into the environment and retain polluted waters from contaminating other available clean water resources[16].

M.R. Doosti et al, observed that there are different methods of water treatment such as; membrane filtration, turbidity and total suspended solid reduction, algae removal, disinfection process, water softening process and other pollutants removal which can improve the water treatment process environmentally[17]. Seetharam et al, stated that water is one of the most valuable resources, yet it is under constant threat due to climate change and resulting drought, explosive population growth and waste.

They also stated that water has a precious value and each drop must be accounted for in water scarce regions such as the Middle East and North Africa. Therefore, waste water has to be reclassified as a renewable water resource rather than waste as it helps increase water availability and at the same time prevents environmental pollution[18]. S.S. Turkar et al, stated that the main economic burden associated with water pollution is the effect of pollution on health and that alternative methods can be used to further treat or distribute the treated effluence[19].

Yolanda Agular et al in their study titled "A Comparative Study of Waste water Treatment Methods of Selected Multinational and Local Beverage Companies in Philppines and Their Effects on Environment", stated that waste water treatment is the process of removing existing contaminants to make water become fit for disposal or reuse[20].

Methodology

The pearson product - moment correlation coefficient: The Pearson Product –moment correlation coefficient is used in the analysis of the data since it is the familiar measure of dependence between two quantities.

$$(r) = \frac{N\sum XY - (\sum X)(\sum Y)}{\sqrt{[N(\sum X^2) - (\sum x)^2][N(\sum Y^2) - \sum(Y)^2]}} \quad (1)$$

Significance Tests for Correlation Coefficient: The coefficient r, which we calculated from a sample, is an estimate of the population parameter, ρ. Interest, is therefore, usually, in using this sample estimate to test hypothesis about the population. The most common significance test is on whether there is, in fact, a non-zero correlation between the two populations of interest. In other words, we test the null hypothesis.

Hypothesis: H_0: The amount of chlorine and fluoride is not too much in the water treatment. Against the alternative hypothesis.

H_1: The amount of chlorine and fluoride is too much in the water treatment. In order to test the significance of the r value, we need to convert the value of the correlation to a t- value.

The formula to be used is

$$\boldsymbol{t = r\sqrt{\frac{N-2}{1-r^2}}} \text{ (N-2 degree of freedom)} \quad (2)$$

Where $r =$ the value of the coefficient obtained
N = number of observations

The t student distribution table is also used to obtain the value from the table using the formula below.

$$t_{1-\frac{\alpha}{2},\ N-2} \quad (3)$$

Decision Rule: Accept H_0 at the $\alpha = 0.05$ significance level if

$$|t| \leq t_{1-\frac{\alpha}{2},\ N-2} \quad (4)$$

Analysis of Variance (ANOVA): Analysis of Variance is also used in analysing the data. Analysis of variance makes it possible to ascertain the proportion of the variation in the data set.

$x_{ij} =$ The i[th] observation for the jth treatment, $i = 1, 2 \ldots . n_j; j = 1, 2, \ldots r.$

Equations 5, 6, 7 below are used to find the sum of square variation for the total, treatment and the error sum of square variation

$$\text{Total} = SS_{Total} = \sum_{j=1}^{r}\sum_{i=1}^{n_j} X^2 ij - \frac{T^2}{N} .. \quad (5)$$

$$\text{Treatment } SSt_{reatment} = \sum T.j^2 - \frac{T^2..}{n_j} \quad (6)$$

$$\text{Error} = \sum_{j=1}^{r}\sum_{i=1}^{n_j} x^2 ij - \frac{T^2}{n_j} .. \quad (7)$$

The degrees of freedom: The degrees of freedom for 'between treatment', 'within treatment' and 'total' are given below as Equation (8).

$$\text{Between treatment } r-1, \text{ within treatment } N-r, \text{ Total } N-1 \quad (8)$$

The means squares for 'between treatment' and 'within treatment' is represented in equation (9).

$$\text{Between treatment} = MST = \frac{SST}{r-1}, \text{ Within treatment} = MSE = \frac{SSE}{N-r} \quad (9)$$

The F Ratio is given by Equation (10)

$$F - Ratio = F^* = \frac{MST}{MSE} \quad (10)$$

Decision Rule: Accept H_0 if $F^* < F_{1-\alpha,r-1,N-k}$

And accept H_1 if $F^* > F_{1-\alpha}; r-1, N-k.$

Results and discussion

The Correlation of Chlorine and Fluoride$= 0.066 \approx 0.1$

P-value $= 0.656$

Testing the significance of the correlation ρ at t-value yields $0.448611922 \approx 0.5$

The value from the t distribution table at $t_{0.975,}, 46 = 2.014$

The result shows that the amount of chlorine and fluoride in the treatment of water is not too much.

The result from the Analysis of Variance shows that the amount of chlorine and fluoride applied into water for the treatment is not too much and so the null hypothesis is also not rejected here.

Conclusion

Based on the analysis conducted, the results show that the amount of chlorine and fluoride used in the treatment of water in Taraba State was not in excess in 2015. The Taraba State Water Board should constantly keep the application of chlorine and fluoride in perfect control so as to avoid ill-treatment of water in the near future.

Table-1: Data on the amount of Chlorine and Fluoride used in water purification

Days/Months	Chlorine	Fluoride	Days/Months	Chlorine	Fluoride
01/01/2015	48	0.40	02/07/2015	15.4	1.55
08/01/2015	26.9	0.42	09/07/2015	0.8	1.68
15/01/2015	36.5	0.00	23/07/2015	6.5	1.75
29/01/2015	14.8	o.20	30/07/2015	10.4	1.70
05/02/2015	48	0.40	06/08/2015	2.6	1.55
12/02/2015	30	0.72	13/08/2015	4.6	0.8
19/02/2015	20	1.3	20/08/2015	4.4	0.7
26/02/2015	9.6	0.05	27/08/2015	4.5	1.0
05/03/2015	24.6	0.6	03/09/2015	20	0.5
12/03/2015	25.6	0.6	10/09/2015	35	0.5
19/03/2015	5.4	0.5	17/09/2015	24.5	1.2
26/03/2015	5.4	0.8	24/09/2015	30.2	0.5
03/04/2015	12.4	0.4	07/10/2015	42	0.6
10/04/2015	9.5	0.5	14/10/2015	27.5	0.5
17/04/2015	18.4	0.5	21/10/2015	46.6	1.0
24/04/2015	2.6	1.45	28/10/2015	10.6	1.0
08/05/2025	2.4	1.55	08/11/2015	6.5	0.5
15/05/2015	3.0	1.65	12/11/2015	6.6	0.6
22/05/2015	4.8	1.75	19/11/2015	6.0	0.6
29/05/2015	0.8	1.68	26/11/2015	15.4	0.6
04/06/2015	0.4	1.53	03/12/2015	15.4	0.5
11/06/2015	15.4	1.55	10/12/2015	52	1.2
18/06/2015	0.8	1.65	17/12/2015	35	15
25/06/2015	0.4	1.50	24/12/2015	20.5	0.5

Source: Taraba State Water Board.

Table-2: Analysis of Variance table

Analysis of Variance Table					
Source	Degree of freedom	Sum of Square	Mean Square	F-Ratio	P-Value
Regression	1	0.9.3	o.903	0.20	0.656
Error	46	206.290	4.485		
Total	47	207.193			

From the table above, we discovered that the F-Ratio $= 0.20$. The value from the F distribution table $F_{0.95}1, 46 = 4.056$

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