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EFFECTS OF DYE WASTE MATTER ON WATER POLLUTION: EVIDENCE FROM RIVER SHEHURI SOUTH, MAIDUGURI, NIGERIA

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ABSTRACT

A study on dye waste water was conducted in Maiduguri, Borno State in January, 2012 with the aim of determining the level of pollution of the area over time. This is of great concern to the people/animals residing there. Waste water samples (originating from dye activity) were collected daily in already pre-cleaned plastic containers for a paired of three (3) weeks and labeled appropriately. The samples were digested and analyzed for p^H, metals (Cu, Fe, Cl, Pb, Cr, Ni, Cd, Mn, As, Hg); pollution indicators, DO, BOD, TDS and TOC using standard methods. Results show high temperature (27.3^oc – 28.1^oc); p^H (10.5 – 12.1); BOD (8.0 – 9.0mg/l) Pb (0.1 – 0.25) and Cu (0.90 – 2.30mg/l) respectively. Canonical Correlation analysis shows a canonical R of 0.91 $p<0.05$ and a relationship between the minerals and pollution indicators.

KEYWORDS: Dye Waste Water, Pollution, Shehuri, Maiduguri, Canonical Correlation

INTRODUCTION

In Northern Nigeria, different communities and ethnic groups use numerous plants as dying agents. This has greatly influenced cultural acceptability and easy method of survival. The synthesis of organic dye was introduced in 1871 and was practiced in Egypt, Persia, China and India thousands of years ago using natural materials derived from insects, plants, shellfish etc. as dye stuff (Radojeric and Baskin, 1999).

Dyes are generally fast as they retain their colour in the fibre throughout the textile making process and under exposure to normal wear including sunlight, water and detergent washing. Dye is a soluble compound that can either be absorbed or retained by the fibre. The production of dye is usually associated with several intermediate products and waste which are usually toxic and bio-hazardous and often disturb the environmental equilibrium (Sharma; 2000, ASTM; 1980, APHA; 1989).

Wastewater entering into river from an effluent pipe outlet can be considered as point source pollution. The concentration of pollutant is expected to decrease with increasing distance downstream from the source owing to dilution (Ademorati, 1996). The pollutant in wastewater presents a specific pollution problem while bacteria in water degrade the organic pollutants.

Most environmental monitoring has been based on chemical analysis of water, air and soil. This allows for identification of sources and pathways of pollution and the thought is that some of the chemical changes are biologically relevant. Water pollution in Maiduguri is a common feature most especially during the rainy season when surface run-offs or leachates flows into the rivers. This occurs where liquid resulting from decomposed solid wastes run through open dump sites (Omoleke, 2004) or through canals where the liquid waste poured into then flows to the river.

Maiduguri town is located at $11^o50'$ N and $13^o09'$ E of Borno State and the outlets of the dye processing unit leads to a river (Ngadda) which is mainly used by the people as source of water for domestic purposes. The aim of this study was to ascertain the extent of pollution of the water and its effect on water minerals and other physical

characteristics. This will serve as baseline information necessary for effective monitoring of the site since villages along the river make use of the water domestically. However, the use of conventional anaerobic biological system in the treatment of wastewater has been relatively limited (Hall E.R; 2007, Senji S. and Deminer G. N; 2003).

METHODOLOGY

Dye waste water samples were collected from source as well as discharge point (river) in already precleaned and labeled plastic containers of 24 hours, interval for 3 weeks. The samples were kept in refrigerator for preservation before analysis.

Digestion of Samples

The beaker, 100cm^3 of sample was transferred and 5cm^3 of aqua regia (HNO_3: HCl ratio 3:1) was added. The beaker with its content was placed on a hot plate heated and evaporated in a fume chamber. The beaker was allowed to cool before another 5cm^3 of aqua regia was added. The beaker was further heated until all residues were dissolved in a procedure prescribed by Skoog and West; 1975, Radojevic and Baskin; 1999. The above procedure was repeated for all the samples to be analyzed.

Analysis

- Determination of Heavy Metals

  The digested samples were investigated for heavy metals by atomic absorption spectrometry method using different lamps of specific wavelength suitable for appropriate metal of interest.

- Determination of Organic Pollutants

  The Chloride, BOD, TSS, oil and grease were determined by Ortho-Torhdine, incubation and filtration methods respectively.

- Determination of p^H and Temperature

  The p^H and temperature of the samples were determined on site by the use of standard p^H meter and thermometer respectively.

STATISTICAL DATA ANALYSIS

The data obtained were subjected to different statistical methods using Stat Soft 8 (2007) and SPSS 20.0 (2013) in order to bring out the salient point that influence water pollution. Canonical correlation analysis was performed to determine the effect (joint and individual) effect of pollutions. The pollutants were classified into two groups. Croup one (X) is made up of Chromium, Manganese, Iorn, Lead, Copper, Nitrate and Phenol. Where group two (Y) is made up o water temperature, pH, BOD, TDS and TSS. Confidence intervals were calculated to compare the presence of the minerals with WHO standards.

Graphs were also plotted to help explain the relationship between variables between and within groups.

Canonical Correlation

Procedure for assessing and investigate the relationship between two sets of variable

Assume that the (p+e)x(p+q) correlation matrix between the variables $X_1, X_2, \ldots, X_p, Y_1, Y_2, \ldots, Y_q$ taken the form when calculated from the recorded variables

$$X_1\ X_2 \ldots X_p\ Y_1\ Y_2 \ldots Y_q$$

$$\begin{matrix} X_1 \\ X_2 \\ \vdots \\ X_p \end{matrix} \begin{matrix} pxp \\ A \\ \vdots \end{matrix} \begin{matrix} pxq \\ C \\ \vdots \end{matrix}$$

$$\begin{matrix} Y_1 \\ Y_2 \\ \vdots \\ Y_p \end{matrix} \begin{matrix} qxp \\ C' \\ \vdots \end{matrix} \begin{matrix} qxq \\ B \\ \vdots \\ Y_p \end{matrix} = \begin{pmatrix} A & C' \\ C' & B \end{pmatrix}$$

Define $R = B^{-1}C'A^{-1}\mathrm{C}$

we calculate a pxq matrix R whose eigenvalue are calculated as $(R - \boldsymbol{\lambda I}) = \mathbf{0}$ the $b_i's$ are the eigenvalues which form the coefficient of $Y_i's$ to form the canonical variables while for $X_i's$ column have

$a_i = A^{-1}Cb_i$ thus

$$U_1 = a_{11}X_1 + a_{12}X_2 + a_{13}X_3 + \ldots + a_{1p}X_p$$

$$V_1 = b_{11}Y_1 + b_{12}Y_2 + b_{13}Y_3 + \ldots + b_{1q}Y_q$$

$$V_\gamma = b_{q1}Y_1 + b_{q2}Y_2 + b_{q3}Y_3 + \ldots + b_{q\gamma}Y_q$$

Are linear relationships established, where γ is the smaller of p and q chosen so that the correction between $U_i's$ and $V_i's$ known as canonical variables are maximum. Each of the pair $(U_i, V_i), i = 1, 2, \ldots, \gamma$ represent a different dimension in the relationship between X and Y. the square root of the eigenvalues are the canonical correlation between the canonical variables. Details of the analysis can be obtained in manly B. F. J. (1992), Levie (1997), Bhatia (2011), Bartlett (1947), Giffius (1985), Statsoft (2007), SPSS (2012) reference guide.

RESULTS

From the table 2 it has been established that few variables are relatively correlated, some are positive and some are negative. The canonical correlation R=0.92. the four measured dimensions are shown on table 3 in the appendix their eigenvalues and corresponding and chi square test.

Canonical correlations are given in table 3 in the appendix. It can be seen that only the first linear combination is significant (p<0.05) while the second linear combinations is significant at 20%. The table of extracted variances and redundancies are also given in the appendix for the chemical.

The significant dimension (roots) is given by

$$U_1 = -0.68T + 0.44pH + 0.07BOD + 0.65TDS + 0.17TSS$$

$$V_1 = 0.6Cr + 0.04Mn - 0.33Fe - 0.08Pb - 0.32Cu + 0.54Cl - 0.04NO_2 + 0.22Phen$$

The extracted variance is 0.07 and redundancy 0f 0.06. The first linear combination (U_i) for the physical properties shows the absence of water temperature but the presence of pH, TDS and TSS while the record shows the absence of iorn and copper and the presence of phenol and Chlorine. One can therefore deduce that the presence of pH, TDS and TSS associates with phenol and chlorine to form the water hardness hence unfit for consumption. Also Chromium, Manganese, Iorn, Lead, Copper, pH, BOD, and TSS are all above the WHO standard.

Discussions

Dye waste water of Shehuri South was not as a result of industrial process but rather dye process of changing colour of fabric involving use of various colourants, additives and chemicals respectively. The results obtained from the study showed high BOD (8.0 – 9.0mg/l); PH (10.5 – 12.10); Pb (0.05 – 0.25mg/l); Cr (0.10 – 0.30mg/l); and Cu (0.90 – 2.30mg/l) respectively; this suggests high level of pollutants of the area when compared with W.H.O standard and recommended values.

From table 2, it can be established that few variables are relatively correlated, some are positive and some are negative with the Canonical Correlation R = 0.92. The four measured dimensions, their eigen values, corresponding Canonical Correlation and Chi-Square tests are given on table 3 in the appendix. It can be seen that only the first linear combination is significant ($p < 0.05$) while the second linear combination is significant at 20%. The table of extracted variances and redundancies are also given on the appendix. The significant dimension is given by;

$$U_1 = -0.68T + 0.44p^H + 0.07BOD + 0.65TDS + 0.17TSS$$

$$V_1 = 0.06Cr + 0.04Mn – 0.33Fe – 0.08Pb – 0.32Cu + 0.5Cl – 0.04NO_2 + 0.22Phen$$

The extracted variance is 0.07 and redundancy of 0.06. The first linear combination (U_1) for the physical properties shows the absence of water temperature but the presence of p^H, TDS and TSS while the second shows the absence of Iron and Copper and the presence of Phenol and Chlorine. One can therefore deduce that the presence of p^H, TDS and TSS associates with Phenol and Chlorine to form the water hardness hence unfit for consumption. Also Chromium, Manganese, Iron, Lead, Copper, p^H, BOD and TSS are all above the WHO standard.

CONCLUSIONS

In conclusion, the discharge dye water of Shehuri South was found to be polluted and needs purifier treatment before discharging and people residing around the area should completely avoid the water for both consumption and domestic purposes.

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APPENDICES

Table 1

Mineral	Mean	Standard Error	95% Confidence Interval	WHO Standard
Cr	0.2191	0.0205	0.1734 - 0.2648	0 - 0.05
Mn	0.0782	0.0133	0.0464 - 0.1078	0 - 0.10
Fe	0.3055	0.0342	0.2293 - 0.3817	0 - 0.30
Pb	0.1164	0.0212	0.0692 - 0.1636	0 - 0.01
Cu	1.5682	0.1564	1.2197 - 1.9167	0 - 1.00
NO_2	4.2682	0.0325	4.1958 - 4.3406	0 – 10
Cl	185	1.2721	182.1658 - 187.8342	0 – 200
Phenol	26.8455	0.5947	25.5206 - 28.1705	

Table 2: Physical Characteristics

Type	Sample Size	Mean	Standard Error	95% Confidence Interval	WHO Standard
Temperature	11	27.7455	0.0779	27.5719 - 27.9191	25 - 35
pH	11	11.6591	0.1671	11.2868 - 12.0314	6.8 - 8.5
BOD	11	8.5182	0.1182	8.2549 - 8.7815	0 - 3
TDS	11	148.55	0.4341	147.5828 - 149.5173	0 - 500
TSS	11	545.64	1.5449	542.1980 - 549.0820	7150