



## Concentration of Selected Phenolic Compounds in Effluent, Stream and Groundwater of a Local Textile Industry in Abeokuta, Ogun State, Nigeria

Olufunmilayo Olasumbo Olayinka<sup>1</sup> | Morenikeji Margaret Egbeyemi<sup>1</sup> | Adedayo Olamide Oyebanji<sup>2</sup>✉

1. Department of Environmental Management and Toxicology, Federal University of Agriculture, P.M.B. 2240, Abeokuta, Ogun State, Nigeria

2. Department of Chemical Sciences, Joseph Ayo Babalola University, Ikeji-Arakeji, P.M.B. 5006, Ilesa, Osun State, Nigeria

### Article Info

**Article type:**  
Research Article

**Article history:**  
Received: 22 August 2023  
Revised: 3 November 2023  
Accepted: 21 December 2023

**Keywords:**  
*Phenols*  
*Wastewater*  
*Physicochemical properties*  
*Dye*

### ABSTRACT

Phenols have attracted global interest in the sphere of environmental management due to their potential toxicity on human health. This study determined concentrations of three priority phenolic compounds in effluent and water of a local textile industry in Abeokuta, Nigeria. During tie-dye production, triplicates of effluent, well water, stream and control water were collected three times from five points to give a total of forty-five samples. Physicochemical parameters of samples including temperature, pH, electrical conductivity (EC), total suspended solids (TSS) and total dissolved solids (TDS) were determined according to standard methods while the concentrations of the priority phenolic compounds (4-nitrophenol, 4-chloro-3-methylphenol and 2,4-dinitrophenol) were determined using High Performance Liquid Chromatography equipped with Ultra-Violet detector (HPLC/UV). Data obtained were subjected to descriptive (mean and standard deviation) and inferential (ANOVA) statistics. pH, EC and TSS of effluent and water samples were higher than the permissible limits of World Health Organization (WHO) and Federal Environmental Protection Agency (FEPA) while temperature of the effluent samples and TDS of the well water samples were within standard values. Higher concentrations of the priority phenolic compounds occurred in effluent than water samples but 4-nitrophenol was below detection limit (DL) in water samples. Concentrations of 4-nitrophenol, 4-chloro-3-methylphenol and 2,4-dinitrophenol in effluent exceeded stipulated standard of WHO (0.01 mg/L) and water samples. High concentrations of phenols in water bodies at the local textile industry suggest uncontrolled discharge of effluent from the industry which could eventually reach surface and ground water with potential significant health implications to the populace.

**Cite this article:** Olasumbo Olayinka, O., Margaret Egbeyemi, M., & Olamide Oyebanji, A. (2024). Concentration of Selected Phenolic Compounds in Effluent, Stream and Groundwater of a Local Textile Industry in Abeokuta, Ogun State, Nigeria. *Pollution*, 10 (1), 348-357.  
<https://doi.org/10.22059/POLL.2023.361876.2037>



## INTRODUCTION

Upsurge in industrialisation, population and economy has resulted to degradation of the environment with attendant depletion of natural resources including water (Mofrad et al., 2021; Olayinka, 2004). The textile industry is one of the main sources of severe pollution problems worldwide (Talouizte et al., 2020). It is one of the greatest consumers of water used in operations and producers of large quantity of effluents discharged into the environment untreated (Antunes et al., 2018; Qadir & Chhipa, 2015; Jaishree & Khan, 2013; Sivakumar et al., 2011). Fardhyanti et al. (2017) reported major concern as presence of huge amount of dyes and chemicals of environmental and human health risks in released effluent. Pertinently, increase in demand for textile products has led to increase in wastewater generation (Qadir & Chhipa, 2015). In

\*Corresponding Author Email: [aoyebanji@jabu.edu.ng](mailto:aoyebanji@jabu.edu.ng)

Nigeria, environmental pollution due to effluents generated by local textile industries is one of the problems currently being experienced (Osibote, 2014). Jaishree & Khan (2013) reported that textile industries in many Nigerian cities daily discharge millions of litres of untreated effluents in form of wastewater into public drains and these eventually empty into rivers. These effluents contain wide range of dyes and many organic compounds including phenols (Paul et al., 2012).

Phenolics is a class of organic compounds with a hydroxyl group bonded to an aromatic ring and phenol as the simplest and basic structural unit for other synthetic organic compounds. Some occur naturally in association with colours of some flowers and fruits (Anku et al., 2017) and from decomposition of some plants and animals (Michałowicz & Duda, 2007). Others arise from anthropogenic activities like production of drugs, textiles, dyes, pesticides and paper (Santana et al., 2009). Phenols also occur in various consumer products such as mouthwashes, detergents and antiseptic lotion (Crawford et al., 2008) as well as in surface, ground, rain and drinking waters; air, soil, sediments, food, urban run-off and industrial effluents (Crawford et al., 2008; Zhang et al., 2006). Although food phenols have antioxidant power thereby reducing the risk of development of mutation, diabetics and inflammation and several diseases (Giada, 2013; Shi et al., 2022), most show negative action towards living organisms including humans and the environment because they can injure sensitive cells and consequently cause profound health and environmental issues. Phenols, mainly chlorophenols and nitrophenols including pentachlorophenol, 4-chloro-3-methylphenol, 2,4,6-trichlorophenol, 2,4-dichlorophenol, 2,4-dinitrophenol, 2-methyl-4,6-dinitrophenol, 4-nitrophenol, 2,4-dimethylphenol, 2-nitrophenol, 2-chlorophenol, and phenol, have been classified as priority pollutants by international organizations such as World Health Organization (WHO), United States Environmental Protection Agency (USEPA) and the European Union (EU) (El-Naggar et al., 2022; Santana et al., 2009; Chimuka et al., 2007). This is because of increasing concerns about their toxicity potential and negative impacts on plants, animals, human health and the environment (Ayeni, 2014; Kumar et al., 2014(a)).

Excessive presence of phenol and its derivatives in natural water sources is considered a serious threat to human health and overall water quality. At low concentration of 1 ppb, some phenols in drinking water supplies have been reported to lead to objectionably tasting and odoriferous chlorophenols on chlorination. The detrimental health implications of the toxicity of phenols cannot be compromised (Medjor et al., 2015) as they exhibit high toxicity, mutagenicity, carcinogenicity, endocrine disruption, and vasodilatory activities (Kumar et al., 2014(b)). Due to growing fears about their impact and persistence, the demand for their analysis is on the rise (Medjor et al., 2015; Kumar *et al.*, 2014(b); Bazrafshan et al., 2013). Therefore, it is imperative to determine some polluting phenolics in effluent discharged from the indigenous textile industry in Itoku, Abeokuta. Consequently, the objective of this study was to investigate the presence and concentration of three priority phenolic compounds in discharged effluent, groundwater and stream of a textile industry producing Adire and Kampala in Itoku, Abeokuta, Ogun state, Nigeria.

## MATERIALS AND METHODS

### *Area of study*

Abeokuta, Ogun State capital, Latitude 7° 5' N to 7° 20' N and Longitude 3° 17' E to 3° 27' E, covers a geographical area of 1,256 square kilometres with a population of about 605,461. It is majorly characterised economically by farming, block making, quarrying, sawmilling, local textile making (Adire), trading, pottery and fishing (Soaga & Opeolu, 2009; Adeosun, 2019). The Adire and Kampala (Tie-dye) business contributes substantially to the economy of Abeokuta and Gross Domestic Product (GDP) of the nation by providing income and employment for the local people, generating foreign exchange (Oloyede et al., 2014) through exportation, attraction

of foreign earnings from both regional and international markets and increase in government revenue through tariff and taxes (Soaga & Opeolu, 2009).

The sampling site was an indigenous textile industry in Itoku Market, South Local Government Area of Abeokuta. The industry which produced Adire and Kampala (tie-dye) was operated by illiterates and they cannot quantified waste water generated. The coordinates of the sampling points related to the industry (Point of discharge, Flow channel of discharge of effluent or Pathway, Well and Stream) and Control point are shown in Table 1 while Figure 1 shows Map of the study area.

*Sampling method, frequency of sampling and number of sample*

Grab samples from control and four sampling points by the industry were collected in triplicate at three different periods during production of tie-dye and composited. Collection of samples from points in the industry was achieved by submerging pre-washed amber bottles into environmental media until the bottles were full while collection of samples from the control point and well of textile industry was achieved by using a water fetcher to transfer the samples into the designated pre-washed amber bottles which were retrieved, capped, appropriately labelled and stored as necessary in the ice chest for further preservation and onward transit to the laboratory. A total of forty-five (45) samples were collected and composited into fifteen (15).

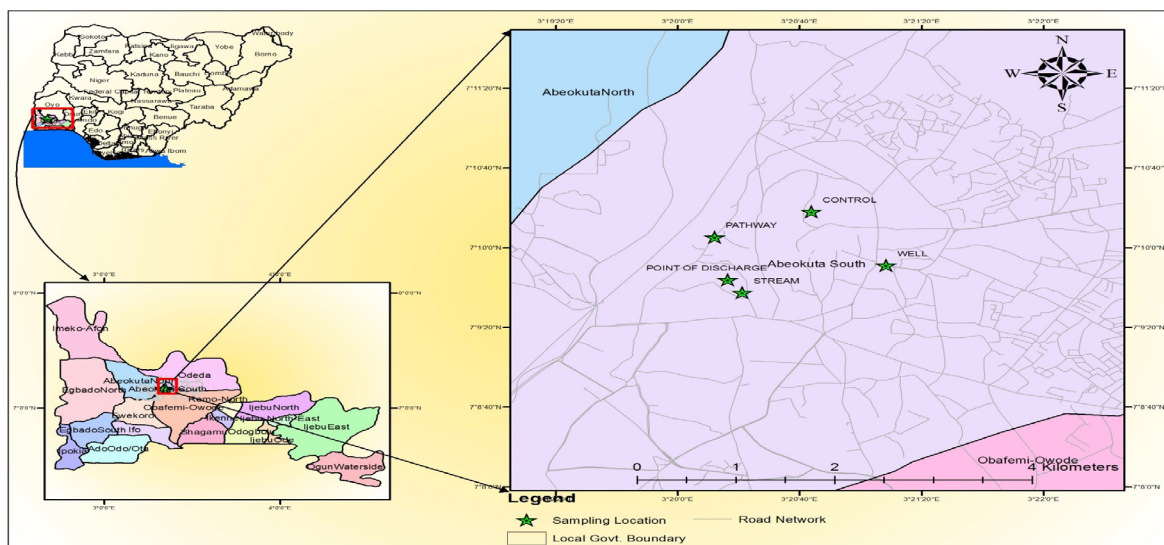
**MATERIALS AND TESTS**

*Physicochemical parameters of samples*

pH, temperature and electrical conductivity of samples were measured *in-situ* using a

**Table 1.** Coordinates of sampling points

S/N	Sampling points	Latitude (°)	Longitude (°)
1.	Point of discharge	7.162208	3.33788
2.	Flow channel of discharged effluent	7.168168	3.336695
3.	Well	7.164227	3.352331
4.	Stream	7.160427	3.339207
5.	Control	7.1812	3.4314



**Fig. 1.** Map of study area

Hanna combo portable meter; while total suspended and total dissolved solids were determined gravimetrically in the laboratory.

#### *Priority phenols in samples*

Samples were further analysed to determine phenols of interest. The method employed was according to Akinnawo (2015). Dichloromethane (DCM) of 40 mL was introduced into 200 mL of the sample in a 1000 mL separating funnel clamped to a retort stand. The separating funnel was shaken vigorously with periodic venting and the sample was allowed to settle for 10 minutes in the funnel to facilitate effective separation of the organic and aqueous phases. After separation, the organic layer was filtered into a 250 mL conical flask through anhydrous sodium sulphate ( $\text{Na}_2\text{SO}_4$ ) that had been prewashed with DCM. The extraction was repeated twice using 40 mL of dichloromethane (DCM) and the extracts were combined to make a whole. The extracts were concentrated to 5 mL using a rotary evaporator at a temperature of 45°C.

Extracts obtained were purified using activated silica-gel clean-up method according to Akinnawo (2015). The cleaning column was packed with 5 g silica gel as impurities adsorbent and capped with anhydrous sodium sulphate salt to serve as water absorbent while n-hexane was used as the eluting solvent. The packed column was pre-conditioned with 10 mL of eluting solvent prior to the introduction of extract to remove trapped air and background contaminants. The re-constituent extract was then transferred into the cleaning column and eluted with 10 mL n-hexane. This enabled the phenols to be washed down as clean extract while interfering contaminants remained in the column. The purified extract was collected into a thoroughly cleaned 100 mL conical flask and was concentrated by allowing it to dry off using a rotary evaporator. The dried extracts were reconstituted with methanol and then transferred into 3 mL vials for further analysis using High-Pressure Liquid Chromatography with Ultraviolet Detector (HPLC-UV).

Identification and quantification of phenols of interest in the samples were carried out using a Cecil 4200 HPLC system which consisted a 150 x 4.6 mm (5  $\mu\text{m}$ ) cyano column with a solvent degasser, quaternary pump, thermostatically controlled column oven set at 40°C and an ultra-violet detector set to collect overall data at a selected wavelength of 280 nm. Mobile phase included Acetonitrile and Acetic acid/Ammonium acetate as solvents A and B respectively at 1:1.45/1 at a flow rate of 1 mL/min; gradient flow of 25% B increased to 75% in 12 minutes with injection volume of 20  $\mu\text{L}$ . Peak identifications were confirmed from retention times, UV-spectrophotometer data, and direct comparison to pure standards.

#### *Statistical analyses of results*

Data obtained were subjected to descriptive, inferential and correlation analyses. Duncan Multiple Range Test (DMRT) was used to separate mean for statistical difference at 95% ( $p = 0.05$ ) confidence level using SPSS 21.0.

## **RESULTS AND DISCUSSION**

#### *Temperature of samples*

The physicochemical properties of effluent and water samples are presented in Table 2. Liquid effluent samples from point of discharge and flow channel had intense blue-black colour while water samples from well and stream of the industry were slightly coloured. The colour of effluent is comparable to blue, blue-black and black reported by (Talouizte et al., 2020). The dissimilarity in colours observed could have been due to different dyes used in the industry. Temperature values of well water and stream of the industry were above the control's temperature (22°C) and WHO (2004) permissible limit (23.5°C) respectively while values for effluents from point of discharge and flow channel were within standards of FEPA (1991) for

**Table 2.** Physicochemical properties of effluent and water samples compared to recommended standards

Parameters	Point of discharge	Flow path	Well	Stream	Control	WHO (2004) Maximum permissible limit	FEPA (1991)
Temperature (°C)	28.00 <sup>a</sup>	28.00 <sup>a</sup>	26.50 <sup>b</sup>	26.50 <sup>b</sup>	22 <sup>c</sup>	23.5	30
pH	13.73 ± 0.68 <sup>a</sup>	11.73 ± 0.12 <sup>b</sup>	9.30 ± 0.20 <sup>c</sup>	9.00 ± 0.31 <sup>d</sup>	7.00 ± 0.20 <sup>e</sup>	8.5	6-9
EC (µs/cm)	15.95×10 <sup>3</sup> ± 77.78 <sup>a</sup>	6.22×10 <sup>3</sup> ± 424.26 <sup>b</sup>	1.93×10 <sup>3</sup> ± 106.07 <sup>d</sup>	1.99×10 <sup>3</sup> ± 219.20 <sup>c</sup>	575.00 ± 35.36 <sup>e</sup>	1000	NA
TSS (mgL <sup>-1</sup> )	3390 ± 121.24 <sup>a</sup>	963.33 ± 846.72 <sup>b</sup>	490.00 ± 52.92 <sup>c</sup>	273.33 ± 5.77 <sup>d</sup>	263.3± 40.42 <sup>e</sup>	NA	30
TDS (mgL <sup>-1</sup> )	43580 ± 17.32 <sup>a</sup>	8906.66± 1809.71 <sup>b</sup>	240.00 ± 79.37 <sup>d</sup>	1586.66± 760.02 <sup>c</sup>	153.33 ± 5.77 <sup>e</sup>	500	2000

effluent discharge (30°C). According to Hannan et al. (2011), the evaporation of a liquid is dependent on its temperature; confirming that high temperature could increase the potential of the discharged effluents to pollute air in the environment. Hannan et al. (2011) further stated that impacts of temperature on diffusivities both in the air and water could influence emissions of ammonia, sulphide and organic compounds into the environment, thus polluting the air.

#### *pH and alkalinity of samples*

The mean pH values ranged from 9.00±0.31 to 13.73±0.61. pH is one of the most important operational water quality parameters (Ali et al., 2006) upon which metabolic processes, heavy metal toxicity and soil permeability depend (Qadir & Chhipa, 2015). pH of well water and stream of the industry were 9.30±0.20 and 9.00±0.31 respectively while 13.73±0.68 and 11.73±0.12 were the respective values for the effluent from point of discharge and flow channel. This shows that the water and effluent samples were highly alkaline in nature compared to the control which had a pH value of 7.00±0.20. The results were higher than the mean value (6.87) reported for effluent samples by Emigilati et al. (2015) but were in accordance with those of Paul et al. (2012) and Qadir & Chhipa (2015). High alkalinity of effluent sample could have been due to the use of bleaching agents and chemicals including sodium hydroxide (NaOH), sodium hypochlorite (NaOCl), sodium phosphate and surfactants used in the processes (Paul et al., 2012; Qadir & Chhipa, 2015). For well and stream samples, high alkalinity was probably due to accumulation of alkaline constituents in effluent discharged directly into the stream or leaching into the well at about 300 m to the point of discharge, high soil porosity, permeability and also rocky nature of study area (Ogunbanjo & Oladapo, 2021). Thus, the effluent needs treatment to reduce its pH to an appreciable extent as prescribed by FEPA (1991) standards before disposal and because values of effluent and water samples were above permissible limit of 8.5 by WHO (2004) and 6–9 by FEPA (1991).

#### *Electrical conductivity, total suspended solid and total dissolved solid of samples*

The EC for well and stream water samples were found to be 1.93×10<sup>3</sup>±106.07 and 1.99×10<sup>3</sup>±219.20 µS/cm respectively. These values were above WHO (2004) permissible limit of 1000 µS/cm. For samples of effluent from point of discharge and flow channel, EC values were 15.95×10<sup>3</sup>±77.78 and 6.22×10<sup>3</sup>±424.26 µS/cm respectively. EC, according to Ali *et al.* (2006), depends on the degree of dissociation of ions, temperature, and migration of ions in the electric field; however, it does not give an idea about the type of ions present. High values of EC depict high conductivity due to the presence of dissolved and dissociated substances (Qadir & Chhipa, 2015; Ali et al., 2006) and suggest that the effluent and water samples could be treated

by physicochemical method of coagulation and flocculation (Sivakumar et al., 2011).

The amounts of TSS in well water and stream samples were  $490.00 \pm 52.92$  and  $273.33 \pm 5.77$  mg/L respectively and were more than that in the control ( $263.33 \pm 90.42$  mg/L). TSS in effluent samples from the point of discharge and flow channel were  $3390 \pm 121.24$  and  $963.33 \pm 846.72$  mg/L respectively and were higher than permissible limit of FEPA (1991) standards (30 mg/L). According to Sivakumar et al. (2011), high values of suspended solids in samples may be attributed to some domestic activities such as washing, defecation, inappropriate dumping of wastes going on around the industry and high colour from various dyestuffs being used.

Subsequently, analysis of water and effluent samples for TDS revealed that the value in the stream was much higher than  $500 \text{ mgL}^{-1}$  prescribed by WHO (2004) and stipulated as the maximum permitted in drinking water by SON (2015). The value in effluent samples was much higher than  $2000 \text{ mgL}^{-1}$  given as FEPA (1991) standard. Values of TDS for well water and stream were  $240.00 \pm 79.37$  and  $1566.66 \pm 760.02$  mg/L respectively whereas values for effluents from point of discharge and flow channel were  $43580 \pm 17.32$  and  $8906.66 \pm 1809.71$  mg/L respectively. Dissolved solids in waste water give an idea of pollution strength (Ali et al., 2006) and a high level of TDS in the effluent samples could be attributed to a number of factors. Some of these factors are high colour from the various dyestuffs used (Hanaan et al., 2011), presence of inorganic salts and organic substances dissolved in water (Awomeso et al., 2011), large number of dissolved salts such as chlorides, carbonates, bicarbonates, sulphates, phosphates, nitrates of sodium, potassium, calcium, magnesium, manganese and iron (Qadir & Chhipa, 2015) as well as activities carried out at the effluent flow channel and stream area of the industry, leading to a variety of health hazards. Such activities include defecation, washing and dumping of wastes. High concentration of TDS may impact taste or odour, affect the density of water, reduce solubility of gases, especially oxygen, influence osmoregulation of freshwater organisms, utility of water for drinking and irrigation purposes (Qadir & Chhipa, 2015). However, Ali et al. (2006) reported that dissolved solids in wastewater destined for agriculture purposes might be as high as 2000 mg/L but below this limit.

All values are means of triplicate determinations. Mean values with the same superscript along the same row are not significantly different from each other at  $p > 0.05$ .

WHO (2004) and FEPA (1991)

#### *Priority phenolic compounds in samples*

Table 3 shows the three priority phenolic compounds detected in the effluent and water samples. It was observed that 4-nitrophenol was below detection limit ( $< \text{DL}$ ) in the well water of the industry which corresponds to result from the control site where 4-nitrophenol was also

**Table 3.** The three priority phenolic compounds detected in the effluent and water samples compared to recommended standards

Samples	Priority Phenolic compounds		
	4NP (mg/L)	4C3MP (mg/L)	24DNP (mg/L)
Effluent from the flow channel	$467.13 \pm 414.99$	$0.47 \pm 0.43$	$959.66 \pm 1428.95$
Well water	$< \text{DL}$	$71.99 \pm 109.88$	$316.78 \pm 116.56$
Stream water	$11.22 \pm 4.85$	$2.69 \pm 4.67$	$125.40 \pm 19.73$
Control water	$< \text{DL}$	$65.23 \pm 56.59$	$170.40 \pm 141.60$
NSDWQ/WHO	0.001	0.001	0.001
FEPA	0.01	0.01	0.01

4NP: 4-nitrophenol; 4C 3MP: 4-chloro-3-methylphenol; 24DNP: 2-4-nitrophenol;

$< \text{DL}$ - Below detection limit;

NSDWQ- Nigerian Standard for Drinking Water Quality proposed by the Standards; Organization of Nigeria (SON) (2007);

WHO- World Health Organization (2003);

FEPA- Federal Environmental protection Agency (1991).

below detection limit (< DL) in the water. This showed that well water and control sites might be free from 4-nitrophenol contamination. However, stream and effluent from flow channel contained 4-nitrophenol at concentrations of  $11.22 \pm 4.85$  mg/L and  $467.13 \pm 414.99$  mg/L respectively, indicating 4-nitrophenol contamination in these two samples which also had values far above permissible limit of Nigerian Standard for Drinking Water Quality by SON (2007)/WHO (2003) [37] –  $0.001 \text{ mgL}^{-1}$  and FEPA (1991) standards –  $0.01$  mg/L. The concentrations of 4-nitrophenol detected in the stream sample and the effluent sample from flow channel were also higher than reported in waste water ( $36.54 \pm 0.02 \text{ }\mu\text{g/L}$ ) by Kumar et al., 2014(a).

It was detected that effluent sample from the flow channel of the industry contained 4-chloro-3-methylphenol and 2,4-dinitrophenol at concentrations of  $0.47 \pm 0.43$  mg/L and  $959.66 \pm 1428.95$  mg/L respectively. Also, 4-chloro-3-methylphenol and 2,4-dinitrophenol were detected in the well water of the industry at concentrations of  $71.99 \pm 109.88$  and  $316.78 \pm 116.56$  mg/L and in stream water at  $2.69 \pm 4.67$  and  $125.40 \pm 19.73$  mg/L respectively. These values were far above the recommended standards of FEPA (1991) –  $0.01$  and SON (2007)/WHO (2003) –  $0.001$ . The concentrations of 4-chloro-3-methylphenol in effluent from the flow channel, well water, stream water and control water were higher than the range ( $7.25$ - $55.32$  ng/L) reported by El-Naggar et al., (2022) in coastal waters of Alexandria, Egypt, and also  $57.32 \pm 0.13 \text{ }\mu\text{g/L}$  observed by Kumar et al., 2014(a) in waste water. Similarly, levels of 2,4-dinitrophenol observed in effluent from the flow channel, well water, stream water and control water far exceeded the level ( $36.42 \pm 0.07 \text{ }\mu\text{g/L}$ ) detected by Kumar et al., 2014(a) in waste water. The presence of these phenols in the effluent and water samples of the industry could be as a result of chemical composition of additives used during processing and manufacturing or as a by-product (Ayeni, 2014). The presence of 4C3MP and 24DNP in the water sample from the control site might be as a result of chlorination of phenols during disinfections, by-products of the reaction of hypochlorite with phenolic acids in biocides, degradation products of phenoxy herbicides and exposure of water to contaminated air or reaction of other pollutants with oxides of nitrogen or a component of the aquatic environment (Anku et al., 2017; Kumar et al., 2014(b); WHO, 2003).

Levels of these three priority pollutants, especially 2,4-dinitrophenol in all the four (effluent from the flow channel, well water, stream water and control water) samples, as well as 4-chloro-3-methylphenol in well water and control water and 4-nitrophenol in effluent from the flow channel and stream water far exceeded the range ( $9$ - $25$  mg/L) of toxicity levels of these pollutants in water for both humans and aquatic life (Mainali, 2020; Sharma & Bhattacharya, 2017).

Tables 4 and 5 show the correlations of 4-chloro-3-methylphenol (4C3MP) and 2,4-dinitrophenol (24DNP) respectively in the effluent and water samples. In Table 4, the values of 4C3MP in the effluent sample from the flow channel was positively correlated to the value of 4C3MP in the water sample from the stream ( $r = 0.138$ ) but negatively correlated with the values of 4C3MP in the well water ( $r = -0.157$ ) and control site ( $r = -0.902$ ). This confirms the positive relationship between the flow channel and the stream since effluent flows to the stream through the flow channel and strong negative relationship between the effluent from the flow channel and water at the control site since they are not in the same location. The correlation

**Table 4.** Correlation of 4-chloro-3-methylphenol (4C3MP) in effluent and water samples from the different sampling points

Sampling points	Flow channel	Well	Stream	Control
Flow channel	1			
Well	-0.157	1		
Stream	0.138	-0.999*	1	
Control	-0.902	0.568	-0.552	1

\* Correlation is significant at the 0.05 level (2-tailed)

**Table 5.** Correlation of 2,4-dinitrophenol (24DNP) in effluent and water samples from the different sampling points

Flow channel	1			
Well	0.663	1		
Stream	0.989*	0.546	1	
Control	-0.330	-0.188	-0.925*	1

\*Correlation is significant at the 0.05 level (2-tailed)

coefficient value obtained for 4C3MP in well water and stream of the industry and control site is a function of very strong negative relationship that exists between the well water and stream of the industry ( $r = -0.999$ ) and strong positive relationship with water at the control site ( $r = 0.568$ ). Values of the water sample from the stream was significantly not correlated with the values of control site ( $r = -0.552$ ).

## CONCLUSION

Physicochemical parameters of the effluent and water from the local industry showed extreme fluctuations from the standards. The pollution load in the effluent was much higher than other water samples such that the water quality is affected. Chemical analysis of effluent, well water and stream water samples from the industry indicated presence of 4-chloro-3-methylphenol and 2,4-dinitrophenol while 4-nitrophenol was not detected in the well water sample and the control sample. The presence of these compounds in samples indicated that effluents generated from the production of local textiles in Itoku, Abeokuta, were untreated wastewater which when discharged into the environment could affect surrounding water bodies and the environment at large. Finally, a periodic water quality monitoring programme should be encouraged in the study area to ascertain the level of priority phenolic compounds and also to uphold sustainable environmental aesthetics. We recommend effluent treatment plant utilising physicochemical and biological treatment methods or appropriate technology should be installed to treat generated effluent before discharging such into the surrounding water bodies.

## ACKNOWLEDGEMENT

There is no acknowledgement.

## GRANT SUPPORT DETAILS

The present research did not receive any financial support.

## CONFLICT OF INTEREST

The authors declare that there is no conflict of interests regarding the publication of this manuscript.

## LIFE SCIENCE REPORTING

No life science threat was practiced in this research.

## REFERENCES

Adeosun, F. I. (2019). Effects of anthropogenic activities on water quality, and phosphate and nitrates



- in the sediment of River Ogun at Ijaye, Isabo and Oke-sokori, Ogun State. *Int. J. Biol. Chem. Sci.*, 13(3); 1261-1270.
- Akinnawo, S. (2015). Determination of organochlorine pesticides residues in water and sediment samples from selected areas of River Ilaje, Nigeria. *Am. Chem. Sci. J.*, 11(2); 1-6.
- Ali, S., Nadeem, R., Bhatti, N. H., Chatha, S.A.S., & Muneer, M. (2006). Analyses and treatment of textile effluents. *Int. J. Agric. Biol.*, 8(5); 1-4.
- Anku, W. W., Mamo, M. A., & Govender, P. P. (2017). Phenolic Compounds in Water: Sources, Reactivity, Toxicity and Treatment Methods. (In M. Soto-Hernandez, M. Palma-Tenango and M. R. Garcia-Mateos (Eds.), *Phenolic Compounds-Natural Sources, Importance and Applications* (pp. 419-443). London: InTechOpen).
- Antunes, R. S., Ferraz, D., Garcia, L. F., Thomaz, D. V., Luque, R., Lobón, G. S., Gil, E. S., & Lopes, F. M. (2018). Development of a polyphenol oxidase biosensor from Jenipapo Fruit Extract (*Genipa americana* L.) and determination of phenolic compounds in textile industrial effluents. *Biosens.*, 8; 47.
- Awomeso, J. A., Taiwo, A. M., Morawo, O. A., & Moyosore, J. O. (2011). Possible abstraction sites along Osun River lower course in Ogun and Lagos States, Nigeria for sustainable supply of potable water. *J. Sci. and Technol.*, 31(3), 58-67.
- Ayeni, O. (2014). A preliminary assessment of phenol contamination of Isebo River in South-Western Nigeria. *Greener J. Phys. Sci.*, 4(2); 30-37.
- Bazrafashan, E., Mostapour, K. F., & Mansoverian, J. H. (2013). Phenolic compounds: health effects and its removal from aqueous environments by low cost adsorbents. *Health Scope*. 1970 Winter. 2(2); 65-66.
- Chi muka, L., Nefale, F., & Masevhe, A. (2007). Determination of phenols in water samples using a supported liquid membrane extraction probe and liquid chromatography with photodiode array detection. *South Afr. J. Chem.*, 60; 102-108.
- Crawford, J., Faron, O., Wilson, J., Lladós, T. F., Garber, K., Paulcott, S., & Lumpkin, M. H. (2008). Toxicology profile for phenols. (Agency for Toxic Substances and Diseases Registry, Division of Toxicology, and Environmental Medicine/ Applied Toxicology Branch, Atlanta, Georgia)
- El-Naggar, N. A., Moawad, M. N., & Ahmed, E. F. (2022). Toxic phenolic compounds in the Egyptian coastal waters of Alexandria: spatial distribution, source identification, and ecological risk assessment. *Water Sci.*, 36(1); 32-40.
- Emigilati, M. A., Ishiaku, I., Usman, B. Y., Kuta, G. I., & Dangana, K. (2015). Assessment of effluents discharged from textiles industries in selected villages in Kaduna State, Nigeria. *Afr. J. Environ. Sci. and Technol.*, 9(5); 385-389.
- Fardhyanti, D. S., Prasetiawan, H., Harmawan & Sari, L. S. (2016, October). Ternary liquid-liquid equilibria for the phenolic compounds extraction from artificial textile industrial waste, (Paper presented at 5th International Conference on Education, Concept and Application of Green Technology, Indonesia)
- Federal Environmental Protection Agency (FEPA), (1991). Guidelines and Standards for Environmental Pollution Control in Nigeria, Federal Environmental Protection Agency Regulation 1991 on Pollution Abatement in Industries and Facilities Generated Wastes. 1-238.
- Giada, R. M. (2013). Food phenolics compounds: Main classes, sources and their antioxidant power. (In J. A. Morales-González (Ed.), *Oxidative Stress and Chronic Degenerative Diseases- A Role for Antioxidants*, (pp. 87-112). London: InTechOpen).
- Hannan, M. A., Rahman, M. A., & Haque, M. P. (2011). An investigation on quality characterization and magnitude of pollution implications with textile dyeing industries' effluent using bleaching powder. *Duet J.*, 2(1); 49-59.
- Jaishree & Khan, T. I. (2013). Physico-chemical analysis of textile wastewater around agricultural field in Sanganer town, Jaipur. *Global J. of Biosci. and Biotechnol.*, 2(3); 455-460.
- Kumar<sup>a</sup>, B., Verma, V. K., Sharma, C. S., & Akolkar, A. B. (2014). Quick and easy method for determination of priority phenolic pollutants in water and wastewater. *J. Xenobio.*, 4(4680), 46-52.
- Kumar<sup>b</sup>, B., Tyagi, J., Verma, V. K., Sharma, C. S., & Akolkar, A. B. (2014). Distribution of eleven phenolic compounds in soils from mixed land use and assessment of health hazard for human population. *Adv. Appl. Sci. Res.*, 5(2); 125-132.
- Mainali, K. (2020). Phenolic Compounds Contaminants in Water: A Glance. *Curr. Trends in Civil and Struct. Eng.*, 4(4); 1-3.

- Medjor, W. O., Wepuaka, C. A., & Godwill, S. (2015). Spectrophotometric determination of phenol in natural waters by trichloromethane extraction method after steam distillation. *J. Pure Appl. Chem.*, 7(3); 150-156.
- Michalowicz, J., & Duda, W. (2007). Phenols transformation in the Environment and living organisms. *Curr. Top. Biophy.*, 30; 24-36.
- Mofrad, M. M. G., Parseh, I., & Mahdavi, M. (2021). Hazardous and industrial wastewaters: from cutting-edge treatment strategies or layouts to micropollutant removal. (In A. W. Mohammad and W. L. Ang (Eds.), *Integrated and hybrid process technology for water and wastewater treatment*, (pp. 233-251). India: Susan Dennis).
- Ogunbanjo, O. O., & Oladapo, F. O. (2021). Speciation and quantification of labile heavy metal discharges in Ogun Rivers using DGT technique. *J. Chem. Soc. Nigeria*, 46(4); 0772-0784.
- Oloyede, A. M., Ogunlaja, O., & Ogunlaja, A. (2014). Sub-chronic toxicity assessment of local textile adire and kampala (tie and dye) effluents on Mice (*Mus musculus*). *Res. J. Environ. Sci.*, 8(3);142-148.
- Olayinka, K. O. (2004). Studies on industrial pollution in Nigeria: The effect of textile effluents on the quality of groundwater in some parts of Lagos. *Nigerian Journal of Health and Biomedical Sciences*, 3; 44-50.
- Osibote, I. A., Ogunjobi, A. A., & Okwuobi, N. P. (2014). Microbial treatment of complex dyes used in local textile industries in Nigeria. *World Appl. Sci. J.*, 31(5); 698-704.
- Paul, S. A., Chavan, S. K., & Khambe, S. D. (2012). Studies on characterization of textile industrial wastewater in Solapur city. *Int. J. Chem. Sci.*, 10(2); 635-642.
- Qadir, I., & Chhipa, R. C. (2015). Comparative studies of some physicochemical characteristics of raw water and effluents of textile industries of Sitapur, Jaipur. *Int. J. Adv. Res.*, 3(6); 2444-2449.
- Santana, C. M., Ferrera, S. Z., Padron, T. E. M., & Rodriguez, S. J. J. (2009). Methodologies for the extraction of phenolic compounds from environmental samples: New approaches. *Molecules*, 14; 298-230.
- Sharma, S., & Bhattacharya, A. (2017). Drinking water contamination and treatment techniques. *Appl. Water Sci.*, 7(3); 1043-1067.
- Shi, L., Zhao, W., Yang, Z., Subbiah, V., & Suleria, H. A. R. (2022). Extraction and characterization of phenolic compounds and their potential antioxidant activities. *Environ. Sci. Pollut. Res.*, 29; 8112-81129.
- Sivakumar, K. K., Balamurugan, C., Ramakrishnan, D., & Bhai, L. H. (2011). Assessment studies on wastewater pollution by textile dyeing and bleaching industries at Kabur, Tamil Nadu, Rasayan. *J. Chem.*, 4(2); 264-269.
- Soaga, J. A., & Opeolu, B. O. (2009). The profitability, health and environmental implications of Adire production in Abeokuta, Ogun state, Nigeria. *Journal of Agric. Sci. Environ.*, 9(2); 25-23.
- Standards Organization of Nigeria (SON) (2007). Nigerian Standard for Drinking Water Quality (NSDWQ), (Lagos: Nigerian Industrial Standards)
- Standards Organization of Nigeria (SON) (2015). Nigerian Standard for Drinking Water Quality (NSDWQ). (Lagos: Nigerian Industrial Standards)
- Talouizte, H., Merzouki, M., Benlemlih, M., & Amraoui, M. B. (2020). Chemical characterization of specific micropollutants from textile industry effluents in Fez City, Morocco, Hindawi. *J. Chem.* 1-11.
- World Health Organisation, (2003). Chlorophenols in drinking water: Background Document for Development of WHO Guidelines for Drinking-Water Quality. (Geneva, WHO)
- World Health Organisation, (2004). Guidelines for Drinking-water Quality, 3<sup>rd</sup> Edition, Volume 1 Recommendations. (Geneva, WHO)
- Zhang, T., Chen, X., Liang, P., & Leu, C. (2006). Determination of phenolic compounds in wastewater by liquid-phase micro extraction coupled with gas chromatography. *J. Chromatogr. Sci.*, 44; 619-726.