Int.J.Curr.Microbiol.App.Sci (2018) *7*(6): 3800-3807

International Journal of Current Microbiology and Applied Sciences
***ISSN: 2319-7706* Volume 7 Number 06 (2018)**
Journal homepage: http://www.ijcmas.com

Original Research Article https://doi.org/10.20546/ijcmas.2018.706.446

Microbiological and Physicochemical Assessment of Soil Contaminated with Dye Effluent in Sokoto State, Nigeria

Nafi'u Abdulkadir[1*], Hauwa B. Abubakar[1], M. H. Usman[1], A. Sanusi[5], G. Mustapha[1], M. Sirajo[2], B. Muhammad[3], Safina A. Yerima[4] and Bashar B. Ladan[1]

[1]Microbiology Department Sokoto State University, Along Birnin Kebbi Road Sokoto State Nigeria
[2]Department of Chemistry Sokoto State University, Along Birnin Kebbi Road Sokoto State Nigeria
[3]Department of Microbiology Bayero University Kano, Kano State Nigeria
[4]Department of Biology Shehu Shagari College of Education, Sokoto Nigeria
[5]Department of Biological Science University of Science and Technology Aleiro, Kebbi State Nigeria

**Corresponding author*

Keywords

Physico-chemical, Microbiological, Soil, Synthetic dye, Effluent discharge, bacteria viable count

Article Info

Accepted:
25 May 2018
Available Online:
10 June 2018

A B S T R A C T

The study was aimed to investigate the quality of soil polluted with dye effluents in Sokoto. Soil samples were collected from different dying centers in Sokoto in order to determine microbiological and physicochemical changes of soil using standard procedures. The results revealed the average count of viable bacteria in sampling sites that range from (1.05×10^6cfu/g – 1.5×10^5cfu/g) compared to that in control site (5.1×10^5cfu/g) while the fungi were (2.0×10^4 –5×10^4 cfu/g). The results showed that the soil sample contained different genera of microorganisms which include: *Bacillus cereus, Bacilli subtilis, Clostridium absonum, Clostridium perfringens, Streptococcus pyogenes, Aspergillus niger, Aspergillus flavus, Alternaria, Sporotrichum, Cladosporium, Curvularia*, as well as *Geotrichum*. Similarly, the physicochemical analysis of soil revealed high levels of pH (11.1-11.5) in all the sampling sites which exceeded the tolerable levels, while Temperature (29.5^{o}C) Magnesium (66 – 10 mg/kg), Potassium (339 - 440.7 mg/kg), Sodium (98.9-259.9 mg/kg), Calcium (120 – 320 mg/kg), Organic matter (0.58 – 1.96%), Nitrogen (0.05 – 0.09%), and Phosphorus (0.73 – 1.05 mg/ml) Cation exchange capacity (5.68 – 7.04 cmol/kg) in all the sampling sites. Some these levels fall within the permissible levels set by the Federal Ministry of Environment while others are not. The presence of the microorganisms and chemical substances at low levels indicate that there is no much potential threat pose to the inhabitants of the areas.

Introduction

Synthetic organic compounds such as dye are widely used in many different industries to mention a few are textile, leather, plastic, cosmetic and food industries which serve as major sources of environmental pollution. Effluents released from dying industries must

be treated before being discharged in to the environment as it composed of complex mixture of pollutants compound such as organo chlorine based pesticides, heavy metals, pigments and dyeswhich are recalcitrant and toxic to human and animals (Saraswathy and Balakumar, 2009; Levine *et al.,* 1991; Hildenbrand *et al.,* 1999; Martins *et al.,* 2002). Dyes also obstruct light penetration and oxygen transfer that affects water bodies (Franciscon *et al.,* 2009). Textile dye effluents released from different dying centers in Sokoto composed of chemicals that are carcinogenic and toxic to both receiving environment and human, the need for examining microbiological and physicochemical quality of soil is important. Dying chemicals can harm microbial flora in soil and retard the role they played in the environment.

Water pollution occurred as a result of industrial eluent discharged entering into water bodies. It affect aquatic life and eutrophication due to accumulation of toxic substances thereby limiting the amount of oxygen in thewater and hence its quality. Due effluents can disturbed the diversity of soil microbial flora as it contain substance that can play an important role in the soil (Arminder *et al.,* 2010). Azo dyes are the most important synthetic colorants that are widely used in pharmaceutical, textile and painting industries. These group of dye composed of polycyclic; triphenylmethane and anthraquinone compounds pose toxicity, genocity mutagenicity and carcinogenicity effect to human, animals and aquatic life such as fish and some groups of microorganisms (Puvaneswari *et al.,* 2006). Azo dye and Nitrated polycyclic aromatic hydrocarbons are chemicals that are commonly found in the environment that cause pollution to ground water and river in vicinity of dyeing industries (Riu *et al.,* 1998). In developing countries environmental degradation as a result of industrial effluents discharge has become a real problem. In Nigeria the situation is worse where little or no treatment is carried out before discharging the effluent to the environment (Asia *et al.,* 2009). The present study aimed at microbiological and physicochemical assessment of soil receiving dye effluents in different dying centers in Sokoto.

Materials and Methods

Study Area

The study was conducted in Sokoto North and South Local government areas of Sokoto state Nigeria where the main activities of dying are taking place. Dying Centers in Sokoto include among others (Marina Jumu'at Mosque, Marina Clinic, Marina Dallatu, AnguwaRogo and Rima Radio) situated in different areas within Sokoto Metropolis.

Experimental analysis

Sample Collection

Soil samples were collected from dying Centers in Sokoto. A number of soil samples contaminated with dye wastewater were collected using soil sampler and placed in a sterile polythene bags for the period of four (4) weeks. Samples were collected in the morning during the peak of the activities. All samples were labeled and transported to the Microbiology laboratory Sokoto State University for Analysis. Other soil sample were collected five meters (5m) distant away from the site where dying activities are taking placewhich served as control.

Isolation and Characterization of Isolates Microorganisms

The microbiological analyses of soil sample were conducted according to the procedure

described by Neboh *et al.,* (2013). Macroscopic observation on the nature of color, shape, size, elevation and surfaces of the isolates were observed. The characterizations of isolates were done using standard procedure described by Cheesbrough (2006); Oyeleke and Manga (2008).

The bacterial isolates were characterized based on the biochemical reactions. The tests employed in this study were motility, gas production, starch hydrolysis Methyl Red, Vogues Proskauer, catalase, and urease. Morphological characterization for bacterial and fungal isolate was carried out through gram staining, spore stain and lacto phenol blue stains techniques.

Analysis of Physicochemical Parameters of Soil

A number of physicochemical parameters of polluted soil were determined using the standard method of Udo and Ogunwale (1986) and that of Association of Analytical Chemist (AOAC, 1990). The parameters determined were pH, Temperature, Nitrogen, Phosphorus, MagnesiumPotassium, Sodium, Calcium, Total organic carbon and Cations exchange.

Statistical analysis

Data obtained from the study were analyzing using SPSS (Version 20) statistical package. Descriptive statistic through simple graphs, tables and charts were used for presentation of data.

Results and Discussion

The result of physicochemical analysis of polluted soil was presented in Table 1. Different physicochemical parameters were determined and their corresponding standard approved by Federal Ministry of Environment, Nigeria.

The results of physicochemical analysis revealed that some parameters analyzed their values are not within the permissible limits that environment can tolerate in some sampling sites; therefore it has negative impact on the environmental living organism. The results revealed high levels of pH (11.1-11.5) which indicates the soil move toward alkalinity state and it exceeded the permissible limits of (6-9) as in Table 1. The pH in the effluent towards the higher value indicating the alkalinity conditions and thus may have an adverse effect on the soil permeability and growth of soil microbial flora. The high pH of the soil could be due to high concentration of calcium, magnesium and potassium which are generally known to be alkaline.

The possible explanation of high alkalinity could also be linked to increase of bicarbonates and carbonates from effluents. This is in conformity with the finding of Asia *et al.,* (2009) who reported high level of pH (9.36- 9.44) and Temperature (29.1-31.8^{o}C) in studies on the pollution potential of wastewater from textile processing factories in Kaduna Nigeria. The present result is in disagreement to that of Arminder *et al.,* (2016) whose results indicate high pH (8.1 – 9.1) and fall within the permissible limits. Furthermore continuous release of carbon dioxide in to the environment increases pH to alkaline state (Colowick *et al.,* 1998).

The results of the following parameters fall within the permissible level which include temperature (29.5^{o}C), organic matter (0.58 – 1.96), Nitrogen (0.05 – 0.09), Phosphorus (0.73 – 1.05), Magnesium (66 – 120mg/kg), potassium (0.92 – 1.33), sodium (98.9 – 259.9mg/kg), Calcium (120 – 320mg/kg) and Cation exchange (5.68 – 7.04). Similarly, there is a partial difference to that of control sample which could not present much harm to the environment but is indicating pollution at the site.

Table.1 Physicochemical parameters of soil contaminated with dye effluent

Parameters	SMJ	SMC	SMD	SUR	SRR	FMEnv Limit
pH	11.5	11.2	11.1	11.3	8.5	6 – 9.00
Temperature (^{0}C)	29.5	29.5	29.5	29.5	29.5	40.00
Organic matter (%)	0.62	1.96	1.74	0.84	0.58	NA
Nitrogen (%)	0.05	0.07	0.09	0.06	0.04	NA
Phosphorus (mg/kg)	0.77	0.96	1.05	0.77	0.73	5.00
Magnesium (mg/kg)	96.0	102.0	120.0	78.0	66.0	200.00
Potassium (mg/kg)	358.8	440.7	518.7	370.5	339.5	NA
Sodium (mg/kg)	119.6	209.3	259.9	149.5	98.9	NA
Calcium (mg/kg)	210	290	320	190	120	200.00
C.E.C (Cmol/kg)	5.68	6.32	7.04	5.82	5.74	NA

Key: SMJ – Soil from Marina Jumu'at Mosque dye, SMC – Soil from Nearest Marina Clinic dye, SMD – Soil from Marina Dallatu dye, SUR – Soil from UnguwaRogo dye, SRR – Soil from Rima Radio area (control), C.E.C – Cation exchange capacity, FEM-Federal Ministry of Environment.

Table.2 Total viable count bacteria and fungi isolated from soil contaminated with dye effluent

S/N	Sampling sites	Mean±SD count of Bacteria
1	SMJ	$1.5\ X10^6 \pm 2.0\ X10^6$
2	SMC	$5.2X10^5 \pm 6.7X10^5$
3	SMD	$5.04\ X10^5 \pm 7.0\ X10^5$
4	SUR	$5.1\ X\ 10^5 \pm 6.9\ X10^5$
5	SRR (control)	$5.1\ X10^5 \pm 6.8\ X\ 10^5$

Table.3 Frequency and percentage occurrence of bacteria species isolated from soil contaminated with dye effluents

Species	Frequency of isolate	Percentage (%)
Clostridium perfringens	2	20
Clostridium absonum	4	40
Bacillus cereus	2	20
Bacilli subtilis	1	10
Streptococcus pyogenes	1	10
Total	10	100

Table.4 Frequency of occurrence of Fungi isolated from soil contaminated with dye effluents

Species	Frequency of isolate	Percentage (%)
Asperigillus flavus	1	11.11
Asperigillus niger	1	11.11
Alternaria	1	11.11
Cladosporium	1	11.11
Geotrichum	1	11.11
Sporotrichum	4	44.44
Curvularia	1	11.11
Total	10	100

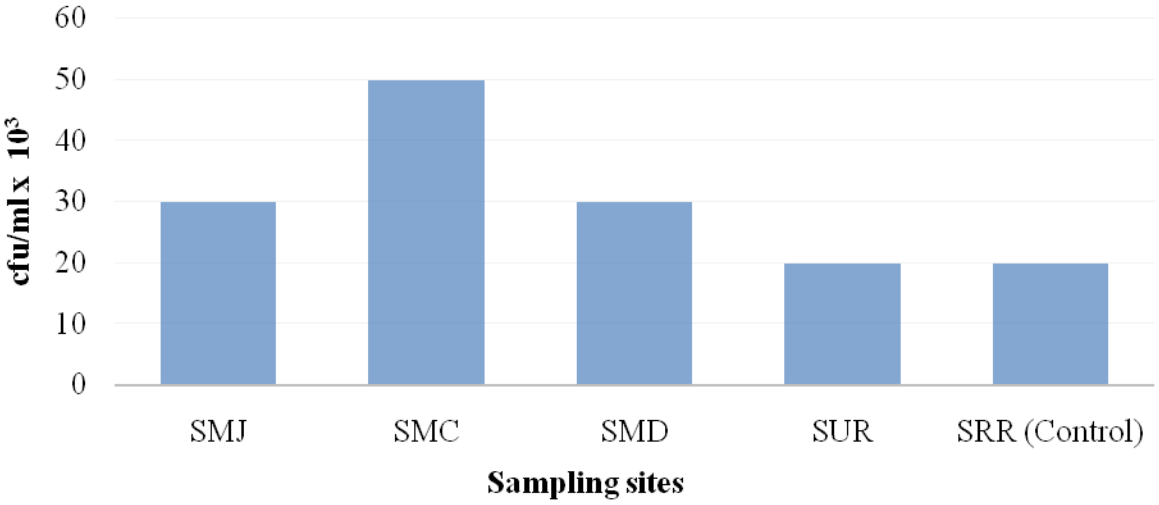

Figure 1: Fungal Enumeration from dye contaminated soil dilution 10^{-3}

This is in disagreement to the finding of Rabah *et al.,* (2010) which indicate low concentration of 2.67 mg/g, 5.60 mg/g for magnesium, phosphorus, potassium and high concentration of 1960 ppm and 76 ppm for calcium. The impacts of temperature in water could influence emissions of both ammonia and sulfide in the effluents while volatilization of oil and grease that could be induced by the same high temperature could introduce organic compounds into the environment thereby polluting the air (EPA, 2001).

The result for enumeration of bacteria isolated is presented in table 2. The average count of total viable bacteria and standard deviation of colonies isolated from textile dye contaminated soil indicated that the bacteria had highest count in polluted soil (1.5 X 10^6cfu/g) compared to that inof a control soil (5.1 X 10^5cfu/g). The high counts of microorganisms in polluted soil indicate that soil may contain certain nutrients that favor the growth of microorganisms which are lacking in the control site. Despite the activities taking place at the dying centers there had been high load of microorganisms in the site. This could be attributed to the capability of microorganism to degrade synthetic dye. Similar results were reported by Rabah *et al.,* (2010), highest count of microorganisms in soil contaminated with abattoir effluent. The finding of Merhi and Sherphirdhin (2016) is in agreement with the results obtained.

The soil sample collected from Marina Jum'at Mosque contains high load of bacterial counts likewise, fewer counts of microorganisms were recorded in soil samples obtained from Marina dying center (Table 2).This could be possible due high number of dying activities taking place at the center that lead tothe release of chemical that might stop metabolic process of the microorganisms in the environment. This may barred or delay natural degradation capacity of pollutants by the indigenous microorganisms. The total viable counts of bacteria from textile dye contaminated soils were found to be similar with the total viable count of another textile

effluent study of (Ekramul *et al.,* 2015). The study is in line with the finding of Orji *et al.,* (2006) revealed the soil samples contained a high density of both bacterial and fungal flora counts in the range of 8.60 – 8.70 × 10^5 cfu/g and 1.70 – 2.0 × 10^4cfu/g. The finding of Arminder *et al.,* (2010) is in disagreement with the present finding of this study who reported high bacterial counts in uncontaminated soil than that in contaminated soil. Decrease in bacterial counts in soil could be attributed to the concentration of Biological Oxygen Demand in the effluents (Arminder *et al.,* 2010).

The colonial characterizations of isolates such as colors, shape, size, elevation and margin were observed which are used for preliminary identification. The results showed total of ten bacterial isolates isolated from parent plates and range (0.1 – 0.4mm) in diameter. The isolated bacteria were further identified by conventional biochemical techniques as described in Bergey's Manual of Determinative Bacteriology. The isolates identified were Gram-positive rods which are *Clostridium absonum, Clostridium perfringens, Bacillus cereus, Bacillus subtilis*and *cocci,* as *Streptococcus pyogenes*. The fungal isolates were identified based on the colour of aerial hyphae, substrate mycelium and arrangement of hyphae, conidial arrangement as well as morphology. The species are *Aspergillus niger, Aspergillus flavus, Alternaria, Sprotrichum, Cladosporium, Curvularia, Geotrichum.*

The results of isolates and their respective frequencies and percentages are in Table (4). *Clostridium absornum* is the bacterial specie identified in this study with highest frequency and percentages of 4(40%) followed *by C. perfringens* and *B. Cereus* each had 2(20%) and *S. pyogenes, B. subtilis* had 1(10%) each. The presence and abundance of various species of *Bacillus* observed in the contaminated soil may not be surprising as these organisms are indigenous to soil environment and are known to persist in such environment (Atlas and Bartha, 2007). *Sporotrichum* was the fungal identified in this study with highest frequency and percentage of 4 and 44.44% followed by *Aspergillus niger, Altenaria A flavus* each had 1(11.1%).This is in agreements with the finding of Ogbonna and Igbenijie (2006) who reported high occurrence of *Proteus* sp, *Streptococcus* sp, *Escherichia coli*, *Fusarium* sp, and *Aspergillus niger* among others in soils of waste collection sites in Port Harcourt city in Rivers State of Nigeria.

The organisms isolated from dye contaminated soil are capable of degrading organic and inorganic compounds in the dye. Despite the toxic and recalcitrant compound in the dye microorganisms continue surviving by strivings the environmental conditions. In similar study genus Bacilli have been reported to possess decolorization capacity. Merlin *et al.,* (2016) reported that *Bacillus subtilis, B. cereus* had capability to decolorize dye.

Also most of the bacterial isolates are predominant to soil environment with the exception of *Streptococcus pyogenes* which is the clinical isolates. This may be as a result of dump and other contaminants presents in the study areas. Osoro (2002) and Orji *et al.,* (2006) reported bacteria belong to the genus Bacillus, Klebsiella, Pseudomanas and fungi belong to the genus *Aspergillus, Penicillium, Aspergillus*, and *Mucor* were predominant in soil contaminated with palm oil effluent. Similar organisms were isolated by Merlin and Sharphudhin (2016) from dye industry effluents isolated such as *Bacillus cereus, Bacillus subtilis, Escherichia coli, Staphylococcus aureus* these bacterial strains have capability to `degradetextile dye effluent as well as to decolorize the dye efficiently in textile effluent.

The study revealed that there are high load of varieties of microorganisms in the dye contaminated soil which indicate their ability to decolorize and degrade the dye. Majority of the organisms are indigenous to soil, spore formers and some are pathogenic organisms. It also revealed that there is partial difference between the counts of microorganisms in contaminated soil to that of uncontaminated soil. The results of physicochemical parameters indicate that most of the parameter their values fall within the permissible limit that the soil microorganisms can toleratewith few exception.

References

Ademoroti CMA (1996a). "*Standard methods for water and effluents Analysis*" Foludex press Ltd., Ibadan.

Ademoroti CMA (1996b). *Environmental Chemistry and Toxicology*. Foludex Press Ltd., Ibadan.

APHA (1995). "*Standard Method for Examination of Water and Wastewater*". 19th Edition. American Public Health Association, Washington D.C.

Arminder Kaur, Siddharth Vats, Sumit Rekhi, Ankit Bhardwaj, Jharna Goel, Ranjeet S. Tanwar, Komal. K. Gaur (2010). Physico-chemical analysis of the industrial effluents and their impact on the soil microflora.*International Society for Environmental Information Sciences 2010 Annual Conference* (ISEIS) Procedia Environmental Sciences 2:595–599

Asia ImohimiOhioma, NdubuisiObejesi Luke and OdiaAmraibure (2009). Studies on the pollution potential of wastewater from textile processing factories in Kaduna, Nigeria. *J. of Tox.andEnv. Health Sci*. 1:2 Pp. 034-037.

Association of Official Analytical Chemists (AOAC) (1990). *Methods of Analysis*, 12th Edition, AOAC, Washington D. C., USA

Atlas, R. M., &Bartha, R. (2007). *Microbial Ecology: Fundamentals and Applications.* Benjamin/Cummings Publishing Company Inc, India.

Cheesebrough, M. (2006).*District laboratory practice in tropical countries*. Part 2. Low Price Edition. Cambridge University Press, London, pp 28-90.

Colowick, S.P., N.O. Kaplan, W.A. Wood and S.T. Kellogg (1988) *Methods in Enzymology*: Biomass: Part A: Cellulose and Hemicellulose, Academic Press, London, UK. 160: 632-634.

Ekramul Md. Karim, KartikDhar and Md. TowhidHossain (2015) Physico-Chemical and Microbiological Analysis of Textile Dyeing Effluents. *J of EnviSci, Tox and Food Techno*. 9:7, Pp. 41-45 DOI: 10.9790/2402-09724145.

EPA, Industrial Waste Air Model Technical Background Document, United States Environmental Protection Agency, USEPA 530-R-02-010, 2001

FEPA (Federal Environmental Protection Agency) (1991), Guidelines to standards for Environmental Pollution Control in Nigeria, Lagos, Nigeria.

Franciscon, E., Zille, A., Dias, G. F., Ragagnin de, M. C., Durrant, L. R., and Cavaco-Paulo, A. (2009). "Biodegradation of Textile Azo Dyes by a Facultative Staphylococcus arlettaeStrain VN-11 using a Sequential Microaerophilic/aerobic process." *Intern J of Biodeter and Biodegra.* 63: 280-288.

Hildenbrand, S., Schmahl, F. W., Wodarz, R., Kimmel, R., and Dartsch, P. C. (1999) "Azo Dyes and Carcinogenic Aromatic Amines in Cell Cultures." *Intern Archives of OccuEnvi and Health* 72: 52–56.

Levine, W. G. (1991) "Metabolism of Azo Dyes: Implication for Detoxification

and Activation." *Drug and Metabolic Res.* 23: 253-309.

Martins, M. A. M., Queiroz, M. J., Silvestre, A. J. D., and Lima, N. (2012). Relationship of Chemical Structure of Textile Dye on the Preadaptation Medium and the Potentialities of their Biodegradation by Phanerochaetechrysosporium."*Res Micro* 153: 361-368.

Merlin Rebekah D, Sharphudhin J (2016) Isolation and characterization of dye degrading bacteria from textile effluent. *Intern J. of Multidisc. Res and Dev.* 3:4, Pp. 177-180 www.allsubjectjournal.com

Neboh, H.A., Ilusanya, O.A, Ezekoye C.C and Orji, F.A (2013). Assessment of Ijebu-Igbo Abattoir effluent and its impact on the ecology of the receiving soil and river.*J. Env. Sci., Tox.and Food Tech.* 7(5): 61-67. www.iosrjournals.org

Ogbonna, D.N. and Igbenijie, M. (2006).Characteristics of microorganisms associated with waste collection sites inPort Harcourt City, Nigeria. *Nig. J.Microbio.* 20(3): 1427-434.

Osaro, E.F. (2002). Microbiological studies ofpalm oil mill effluent from NIFOR, Near Benin city, Nigeria. *Nig. Acad. Forum* 2(2):1-6.

Oyeleke, S.B. and Manga, S.B. (2008). *Essentials of Laboratory Practical in Microbiology*. First Edition, Tolbest Publishers, Minna, Nigeria, pp 36-67.

Puvaneswari N, Muthukrishnan J and P Gunasekaran (2006). Toxicity Assessment and Microbial Degradation of Azo Dyes. *Indian J. Exp. Bio*: 44 Pp 618-626.

Rabah A.B. and M.L. Ibrahim (2008). Physico-Chemical and Microbiological Characterization of Soils Laden with Tannery Effluents in Sokoto, Nigeria.*Nigerian J. of Basic and Appl. Sci.* (2010), 18(1):65-71

Rabah, A. B Oyeleke, S. B. Manga, S. B. Hassan, L. G and Ijah, U. J. J. (2010) Microbiological and Physico-Chemical Assessment of Soil Contaminated With Abattoir Effluents in Sokoto Metropolis, Nigeria. *Sci. World Journ 5(3):* 1-4.

Riu J Schonsee and Barcelo' D (1998). Determination of SulfonatedAzo Dyes in Ground Water and Industrial Effluent by Automated Solid-phase Extraction Followed Capillary Electrophoresis/mass spectrometry. *J Mass Spect.*33 Pp 653.

Saraswathy, K., and Balakumar, S. (2009). "Biodecolorization of Azo Dye (Pigmented red 208) Using *Bacillus firmus* and *Bacillus laterosporus*."*J. of BiosciTechn* 1: 1-7.

Udo, E. J. &Ogunwale, J. A. (1986). *Laboratory Manual for the Analysis of Soil, Plant and Water Samples*, 2nd Edition, University of Ibadan, Nigeria.

How to cite this article:

Nafi'u Abdulkadir, Hauwa B. Abubakar, M. H. Usman, A. Sanusi, G. Mustapha, M. Sirajo, B. Muhammad, Safina A. Yerima and Bashar B. Ladan. 2018. Microbiological and Physicochemical Assessment of Soil Contaminated with Dye Effluent in Sokoto State, Nigeria. *Int.J.Curr.Microbiol.App.Sci.* 7(06): 3800-3807. doi: https://doi.org/10.20546/ijcmas.2018.706.446