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Research Paper

Quantification of the Heavy Metals in the Groundwater of IKEJA Industrial Estate, IKEJA Lagos

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Abstract
This study investigated the heavy metals content of the groundwaters in Ikeja industrial estate Lagos for its domestic utility. The research area was mapped out into 5 research stations and water samples were collected from 5 sampling spots in each research stations, bulked and a composite drawn and stored in ice-cooled boxes for analysis. The analytical standards adopted were USEPA 6010 and 6020 and the analytical instrument deployed for the metals determination is Agilent ICP-MS model 7800. The mean result obtained were: Pb, 0.03±0.12mg/l, Cd, 0.06±0.13mg/l, Cr, 0.06±0.21, V, 0.05±0.22mg/l and Hg, 0.05±0.31. The mean result of the heavy metals investigated were subjected to test of significance with ANOVA using SPSS version 29 at 0.05 level of significance. The p-value is 0.21 thus rejecting $H_O$revealing that the groundwater in Ikeja industrial estate is unsafe for domestic use. The study recommends that the companies in Ikeja should adopt best practices in their operations, the already impacted aquifers should be remediated and government Agencies, National Environmental Standard and Regulation Agency (NESREA) monitoring the industries environmental compliance should increase their surveillance to avoid industries deviation from operation codes.

Keywords: *industries, heavy metals, groundwater, pollution, human health*

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I. Introduction

Heavy metals contamination is currently posing a global public health challenge. Heavy metals are metallic elements with high atomic weight (Chu *et al*., 2007; Voutsa, 2016; White *et al*., 2014). Metal exist in ore or synthesized by scientific processes (Nadal, 2008, Bright & Haeley, 2003, Diggs *et al*., 2011). Some heavy such as Cu, Se metals at trace concentration are required for normal function of the body while others such as Pb, Hg are injurious to the biological system even at a low concentration (Uga-Marove *et al*., 2011, Vu & Wu, 2012, Dorival-Garcia, 2012). Industrial activities like mining, manufacturing and processing are the major sources of heavy metals in the environment (Galidon *et al*., 2007, Kinney *et al*., 2008, Zhang *et al*., 2015). Heavy metals contamination occur in the soil, in air as particulate and in the surface and groundwater (Ogwu *et al*., 2022a, Kim *et al*., 2018, Maurkro, *et al*., 2006). Surface water contamination results from input of mining spoils and industrial effluents in the environment (Itogberg *et al*., 2008, Ogwu 2021, Arditsoglou & Vousta, 2008) while groundwater contamination occur through seepage of heavy metalsin industrial effluents into the aquifer environment (Ogwu *et al*., 2021a, Vikelsoe *et al*., 2002, Zirnikowa *et al*., 2014). Sources of contamination through seepage into the groundwater (aquifers) are through agricultural inputs of fertilizers, insecticides and herbicide (Ogwu *et al*., 2021b, Engstrom *et al*., 2012, Walin *et al*., 2016). Waste water treatment plants, groundwater pumpage(Ogwu *et al*., 2022b, Brozoska & Momuszko-Jakoniuk, 2004, Cheng *et al*., 2016). Heavy metal contamination of groundwater also occur through poorly managed industrial wastes from products manufacturing, industrial processing and meat industries (Duke & William, 2008, Amusan *et al*., 2005, Hrsak *et al*., 2001, Tang *et al*., 2010). Consumption of heavy metals contaminated water results in health complication such as cancer, cardiovascular diseases (Toth *et al*., 2016, Inglezakes *et al*., 2014, Pule *et al*., 2012), memory loss osteoporosis, shortness of breath and death (Fromme *et al*., 2002, Shellito, 2016, Atallah, 2015).

The focus of this study is the determination of the heavy metals content of the groundwater of Ikeja industrial estate Lagos for it suitability as portal water. The heavy metals investigated are Pb, Cd, Cr, V, and Hg.

The study was guided by research questions as follow:

i. what are the concentrations of Pb, Cd, Cr, V, and Hg in the groundwaters of Ikeja industrial estate?
ii. are the concentrations of the heavy metals within the maximum permissible concentration (MPC) stipulated by World Health Organization (WHO) 2014 and United States Environmental Protection agency 2008?
iii. can the groundwaters in Ikeja industrial estate be utilized for domestic purpose?

The study was guided by a hypothesis as follow:

H_0: there is no significant difference between the concentration of the heavy metals measured and WHO MPC for heavy metals in water.

Study Area

Figure 1: Map of Ikeja
Source: Map data, (2025)

Ikeja industrial estate is one of the numerous industrial estates that dotsLagos landscape.Situated in Ikeja local government area,which lies within geographical coordinates of latitude 6°.6018'N and 3°.3515°E it has a population of 313, 196 (National Population Census, 2006) and a land area of 6,300 km^2 (Lagos City Fact, 2022). Ikeja is host to numerous industries amongst these are Guiness, Dunlop, Viju Industries, Morrison Industries, Growats Integrated Company, Inlaks Power Solution, Friesland and WAMCO and the environment is the recipient of the wastes generated by these industries.

II. Materials and Methods

Sampling

The research area Ikeja industrial estate was mapped out into research stations based in industrial cluster (Strogi, 2007, Chowdurry *et al*., 2018) and these are Sapara Street Station, Dunlop, Guinness, Berger Paint and Aromire Avenue Station. From each of the stations, water samples were collected from taps and dugout wells from 5 points,each bulkedcomposite drawn fixed with nitric acid and stored in ice cooled boxes for analysis.

Analysis

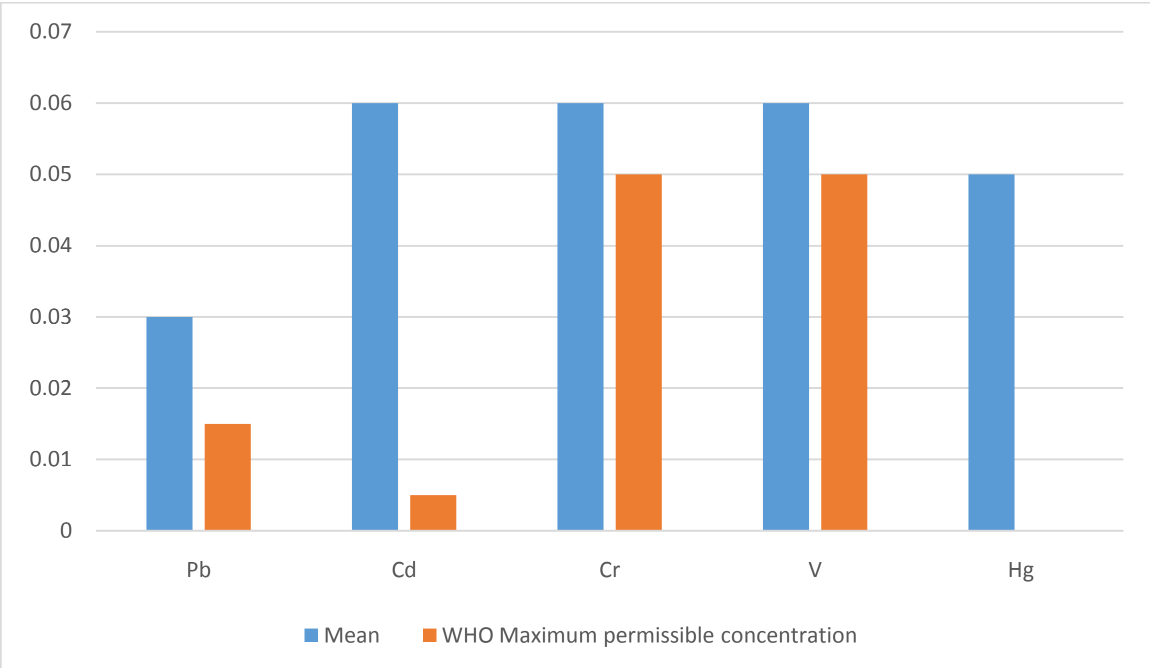
The analytical standards and methods adopted were USEPA 6010 and 6020. The technique adapted involved dual stages. Spectrometer calibration was carried out using mass analyzer a multi-element standard solution together with inductively coupled plasma to obtain a spectrum for calibration curve generation. The second stage involved utilizing the water sample stored in the centrifuge which was then diluted with 5ml of water that was deionized to 5m and the solution then acidified by adding 1% V/v $HNO_3$to increase the concentration of analyte into the already specified range. RH, Re and Ge were then added to improve the occurrence and the sensitivity of inductive couple-mass spectroscopy data. Determination of the heavy metals investigated were then carried out using inductively coupled plasma-mass spectrometer Agilent model 7800 The spectrum generated by the varying metals were used to determine each metal using MCA (multichannel analyser) to compare the calibration curve already calculated.

III. Result

The results of the heavy metals concentration in the groundwaters of Ikeja industrial estate are as in Table 1.
Table 1: results of the heavy metals content of the groundwater of Ikeja industrial estate and WHO MPC in mg/l.

Parameters	Sapara	Dunlop	Guiness	Berger Paint	Avenue Arimare	Mean	SD	WHO Maximum permissible concentration
Pb	0.02	0.05	0.01	0.04	0.05	0.03	0.02	0.015
Cd	0.07	0.06	0.06	0.08	0.06	0.06	0.01	0.005
Cr	0.04	0.06	0.07	0.06	0.07	0.06	0.01	0.05
V	0.06	0.06	0.06	0.05	0.05	0.06	0.03	0.05
Hg	0.03	0.04	0.05	0.06	0.05	0.05	0.01	0.00

The concentrations of the heavy metals in Ikeja industrial estate groundwaters were presented in graph as in Figure 2.
Figure 2: the concentrations of the heavy metals in the groundwater of Ikeja industries estate and WHO MPC in mg/l



The mean results of the heavy metals content of Ikeja groundwater were subjected to test of significance deploying special package for social Science (SPSS) model 29 at 0.05 level of significance. The p-value was 0.21 thus rejecting H_O.

IV. Discussion

The analysis of the water samples from the ground waters in Ikeja industrial estate showed varying concentrations of the heavy metals investigated.

The concentration of Pb range from 0.01 mg/l in gooiness station to 0.05 mg/l in Aromire Avenue with a mean concentration of 0.03 mg/l. The WHO MPC for Pb in water are 0.05. The concentration of Pb in Ikeja industrial estate is within the allowable limit with WHO standard but higher than acceptable limit in USEPA recommendation. Reports of high content of Pb in water was in (Ogwu 2021, Borjac, 2020). Prolonged human exposure to Pb results in brain damage tissues and organ damage and death (Jaishanker *et al*., 2014; Liu, 2007). The results of the analysis of the groundwater in Ikeja industrial estate revealed that the concentrations of Cd is between 0.06 mg/l in Dunlop, Guiness and Aromire Avenue to 0.08 mg/l in Berger Paint with a mean concentration of 0.06mg/l. The WHO MPC for Cd in water is 0.005 mg/l, thus the concentration of Cd is higher than the stipulated.Elevated content of CD in water was in (Balkchair & Astraf, 2016, Pignatello *et al*., 2010). The health complicationsarising from human exposure to Cd are disrupted bone composition, kidney failure and lung disease (Peng *et al*., 2017), Deleke, 2017).

The analysis for Cr in the groundwaters of Ikeja industrial estates showed that Cd concentration range from 0.04 mg/l in Sapara area to 0.07 in Aromire Avenue station with a mean of 0.06 mg/l. WHO MPC for Cr in water is 0.05 mg/l. Increased content of Cr in water was in the reports of (Lasofa & Broriska, 2018, Kalmykova, 2014). Health complications arising from exposure to Cr include liver damage, allergic dermatitis, irregular heart beat (Ogwu *et al*., 2022a, Ogwu *et al*., 2022b, Duke & Williams, 2008).

Heavy metals content analysis of the groundwater of Ikeja industrial estate revealed that the concentrations of V is between 0.05 mg/. in Berger Paint Station and Aromire Avenue to 0.06 mg/l in Sapara, Dunlop and Guiness with a mean of 0.06 mg/l. The WHO and USEPA MPC for V in water is 0.05 mg/l. High content of V in groundwater was in the reports of (Gatidou *et al*., 2007, Kim *et al*., 2018). Complications in human health resulting from ingestion of V contaminated water inclue tremor, headache, abdominal pains, nausea (Ogwu *et al*., 2020, Ogwu *et al*, 2022b). The analysis of Ikeja industrial estate groundwater for heavy metal contamination status showed that Hg content is between 0.03 mg/l in Sapara station to 0.08 mg/l in Berger Paint station with mean content of 0.05 mg/l. WHO MPC for Hg in water is 0.001. Hg in portal water results in health implications of memory loss, tremor, insomnia and **mito** dysfunctions (Zheng *et al*., 2015, Vikelsoe, 2002), increased content of Hg in water was reported in (Ogwu *et al*, 2020, Duke & William, 2008).

V. Conclusion

Groundwater contamination by heavy metals occasioned by industrial activities of mining, manufacturing and agriculture is plaguing public health. Industrialization and agricultural productions are vital for the good standards of living of man but these should be done within ethical codes of operation United Nations Sustainable Development Goals 2015 demands that man enjoys the goods of the environment at present without jeopardizing the opportunity of the utility of the environmental resource by future generation.

The results of this study revealed that Ikeja groundwater is contaminated by heavy metals and therefore not fit for domestic use unless decontamination is carried out.

Consequent upon the results of the analysis, the study therefore recommend that industries operating in Ikeja industrial estate should:

i. device a propermechanisms of waste treatment and disposal
ii. Carryout be remediation of the already impacted areas.
iii. Adhere strictly to codes spelt out by National Environmental Standard and Regulation Agency (NESREA)

REFERENCES

[1]. Adeyi A. A. and Oyeleke P. (2017). Heavy metals and polycyclic aromatic hydrocarbons in soil from e-waste dumpsites in Lagos and Ibadan, Nigeria, Journal of Health and Pollution, vol. 15(2), 71–84.

[2]. Amusan A. A., Ige D. V., and Olawale R. (2005). Characteristics of soils and crops' uptake of metals in municipal waste dump sites in Nigeria, Journal of Human Ecology, 17(3)167–171.

[3]. Arditsoglou A. and Voutsa D. (2008). Determination of phenolic and steroid endocrine disrupting compounds in environmental matrices, Environmental Science and Pollution Research, 15(3), 228–236.

[4]. Atallah S. (2015). Garbage Crisis: Setting 7e Record Straight, +e Lebanese Center for Policy Studies, Beirut, Lebanon, https://www.lcps-lebanon.org/featuredArticle.php?id=48

[5]. Balkhair K. S. and Ashraf M. A. (2016). Microbial contamination of vegetable crop and soil profile in arid regions under controlled application of domestic wastewater, Saudi Journal of Biological Sciences, 23(1), 83–92.

[6]. Bradl H. (2002). Sources and Origins of Heavy Metals Heavy Metals in the Environment: Origin, Interaction and Remediation, H. Bradl, Ed., vol. 6, London: Academic Press.

[7]. Bright D. A. and Healey N. (2003). Contaminant risks from biosolids land application, Environmental Pollution, 126(1), 39–49.

[8]. Brzoska M. M. and Moniuszko-Jakoniuk J. (2004). Low-level exposure to cadmium during the lifetime increases the risk of osteoporosis and fractures of the lumbar spine in the elderly: studies on a rat model of human environmental exposure, Toxicological Sciences: An Official Journal of the Society of Toxicology, 82, 468–477.

[9]. Cheng X., Niu Y., Ding Q *et al*., Cadmium exposure and risk of any fracture: a PRISMA-compliant systematic review and meta-analysis, Medicine, vol. 95, Article ID e2932,

[10]. Chowdhury R., Ramond A., O'Keeffe L. M *et al*. (2018). Environmental toxic metal contaminants and risk of cardiovascular disease: systematic review and meta-analysis, BMJ, 27(3), 362-368.

[11]. Chu S., Haffner G. D., and Letcher R. J. (2005). Simultaneous determination of tetrabromobisphenol A, tetrachlorobisphenol A, bisphenol A and other halogenated analogues in sediment and sludge by high performance liquid chromatography-electrospray tandem mass spectrometry, Journal of Chromatography A, 1097(1), 25–32.

[12]. Codex Alimentarius Commission (2001). WHO, Food additives and contaminants joint FAO/WHO food standards programme, pp. 1–289, Geneva, Switzerland, ALINORM01/12A.

[13]. Diggs D. L., Huderson A. C., Harris K. L. *et al*. (2011). Polycyclic aromatic hydrocarbons and digestive tract cancers: a perspective, Journal of Environmental Science and Health, Part C, 29(4), 324–357.

[14]. Dorival-Garcıa N., Zafra-Gomez A., Navalon A., and Vılchez J. L. (2012). Improved sample treatment for the determination Bisphenol A and its chlorinated derivatives in sewage sludge samples by pressurized liquid extraction and liquid chromatography–tandem mass spectrometry, Talanta, 101, 1–10.

[15]. Duke C. V. A. and Williams C. D. (2008). Soil Pollution Chemistry for Environment And Earth Sciences, Florida: CRC Press: Taylor and Francis Group.

[16]. Engstrom A., Michaelsson K., Vahter M., Julin B., Wolk A., & Akesson A. (2012). Associations between dietary cadmium exposure and bone mineral density and risk of osteoporosis and fractures among women, Bone, 50, 1372–1378,

[17]. Fromme, H., K¨uchler,T., Otto,T.., Pilz,K., M¨uller, J. & Wenzel, A. (2002). Occurrence of phthalates and bisphenol A and F in the environment, Water Research, vol. 36, 1429–1438.

[18]. Gatidou G., Thomaidis N. S., Stasinakis A. S., and Lekkas T. D. (2007). Simultaneous determination of the endocrine disrupting compounds nonylphenol, nonylphenol ethoxylates, triclosan and bisphenol A in wastewater and sewage sludge by gas chromatography-mass spectrometry, Journal of Chromatography A, 1138(2), 32–41.
[19]. Hogberg J., Hanberg A., Berglund M. *et al*. (2008). Phthalate diesters and their metabolites in human breast milk, blood or serum, and urine as biomarkers of exposure in vulnerable populations, Environmental Health Perspectives, 116(3), 334–339.
[20]. Hrsak J., Sisovic A., Skrbec A., and Sega K. (2001). Seasonal differences in the levels of suspended particulate matter and heavy metals in the vicinity of a waste dump, Atmospheric Environment, 35, 3543–3546.
[21]. Hudcova H., Vymazal J., and Rozkosny M. (2018). Present restrictions of sewage sludge applications in agriculture within the European Union, Soil and Water, 14, 104–120.
[22]. Inglezakis V., Zorpas A., Karagiannidis A., Samaras P., Voukkali I., and Sklari S. (2014). European Union legislation on sewage sludge management, Fresenius Environmental Bulletin, vol. 23, 635–639.
[23]. Jaishankar M., Tseten T., Anbalagan N., B. Mathew B., and Beeregowda K. N. (2014). Toxicity, mechanism and health effects of some heavy metals, Interdisciplinary Toxicology, vol. 7(2), 60–72.
[24]. Jarup L. (2003). Hazards of heavy metal contamination,*"* British Medical Bulletin, vol. 68(1), 167–182.
[25]. Kalmykova Y., Moona N., Stromvall A. M., and Bjorklund K. (2014). Sorption and degradation of petroleum hydrocarbons, polycyclic aromatic hydrocarbons, alkylphenols, bisphenol A and phthalates in landfill leachate using sand, activated carbon and peat filters,*"* Water Research, 56(2), 246–257,.
[26]. Kim D., J. Kwak I., and An Y. J. (2018). Effects of bisphenol A in soil on growth, photosynthesis activity, and genistein levels in crop plants (Vigna radiata), Chemosphere, 209, 875–882.
[27]. Kinney C. A., Furlong E. T., Kolpin D. W. *et al*. (2008). Bioaccumulation of pharmaceuticals and other anthropogenic waste indicators in earthworms from agricultural soil amended with biosolid or swine manure, Environmental Science & Technology, 42(6), 1863–1870.
[28]. Lasota J. and Błonska E. (2018)*"*Polycyclic aromatic hydrocarbons ´ content in contaminated forest soils with different humus types, Water, Air, & Soil Pollution, 229(6), 204-209.
[29]. Liu W. X., Shen L. F., Liu J. W., Wang Y. W., and Li S. R. (2007). Uptake of toxic heavy metals by rice (Oryza sativa L.) cultivated in the agricultural soil near Zhengzhou city, People's Republic of China, Bulletin of Environmental Contamination and Toxicology, vol. 79(2), 209–213.
[30]. Manoli E., Kouras A., Karagkiozidou O., Argyropoulos G., Voutsa D., and Samara C. (2016). Polycyclic aromatic hydrocarbons (PAHs) at traffic and urban background sites of northern Greece: source apportionment of ambient PAH levels and PAH-induced lung cancer risk, Environmental Science and Pollution Research, 23(4), 3556–3568.
[31]. MaurIcio R., Diniz M., Petrovic M. *et al*., A characterization of selected endocrine disruptor compounds in a Portuguese wastewater treatment plant, Environmental Monitoring and Assessment, 118(3) 75–87.
[32]. Nadal M., Schuhmacher M., and Domingo J. L. (2004). Levels of PAHs in soil and vegetation samples from Tarragona County, Spain, Environmental Pollution, 132(1), 1–11.
[33]. Peng N., Li Y., Liu T., Lang Q., Gai C., and Liu Z. (2017). Polycyclic aromatic hydrocarbons and toxic heavy metals in municipal solid waste and corresponding hydrochars, Energy Fuels, 31(2), 1665–1671.
[34]. Pignatello J. J., Katz B. G., and Li H. (2010). Sources, interactions, and ecological impacts of organic contaminants in water, soil, and sediment: an introduction to the special series, Journal of Environmental Quality, 39(4) 1133–1138,.
[35]. Pule, B. O., Mmualefe, L. C. and Torto,N. (2012). Analysis of Polycyclic Aromatic Hydrocarbons in Soil with Agilent Bond Elut HPLCFLD, Agilent Technologies, Santa Clara, CA, USA, https:// www.agilent.com/cs/library/applications/5990-5452EN.pdf.
[36]. Shellito K. (2016). The Economic Effect of Refugee Crises on Host Countries and Implication for the Lebanese Case, Penn Libraries, University of Pennsylvania, Philadelphia, PA, USA, https://repository.upenn.edu/cgi/viewcontent.cgi?article=1022&context=joseph_wharton_scholars.
[37]. Srogi K. (2007). Monitoring of environmental exposure to polycyclic aromatic hydrocarbons: a review, Environmental Chemistry Letters, vol. 5(4), 169–195.
[38]. Tang X., Shen C., Shi D. *et al*. (2010). Heavy metal and persistent organic compound contamination in soil from Wenling: an emerging e-waste recycling city in Taizhou area, China, Journal of Hazardous Materials, vol. 173(3), 653–660,.
[39]. Toth G., Hermann T., Da Silva M. R., and Montanarella L. (2016). Heavy metals in agricultural soils of the European Union with implications for food safety, Environment International, 88(2), 299–309.
[40]. United States Environmental Protection Agency (US EPA) (2018). Sewage Sludge (Biosolids), US Environmental Protection Agency (USEPA), Washington, DC, USA, http://water.epa.gov/ polwaste/wastewater/treatment/biosolids/index.cfm.
[41]. Vga-Morales T., Sosa-Ferrera Z., and Santana-Rodrıguez J. J. (2011). Determination of various estradiol mimicking-compounds in sewage sludge by the combination of microwave assisted extraction and LC–MS/MS, Talanta, 85, 1825–1834.
[42]. Vikelsøe J., Thomsen M., and Carlsen L. (2002). Phthalates and nonylphenols in profiles of differently dressed soils, Science of the Total Environment, 296, 105–116.
[43]. Wallin M., Barregard L., Sallsten G. *et al*. (2016). Low-level cadmium exposure is associated with decreased bone mineral density and increased risk of incident fractures in elderly men: the MrOS Sweden study, Journal of Bone and Mineral Research, 31(4) 732–741.
[44]. White A. J., Teitelbaum S. L., Stellman S. D *et al*. (2014). Indoor air pollution exposure from use of indoor stoves and fireplaces in association with breast cancer: a case-control study, Environmental Health, 13, 108.
[45]. Wijngaard R. R., van der Perk M., van der Grift B., de Nijs T. C. M., and Bierkens M. F. P. (2017). The impact of climate change on metal transport in a lowland catchment,*"* Water, Air, & Soil Pollution, 228 (4), 107-111.
[46]. Wuana R. A. and Okieimen F. E. (2011). Heavy metals in contaminated soils: a review of sources, chemistry, risks and best available strategies for remediation, Ecology, 20 (3) 20-24,.
[47]. Yu Y. and Wu L. S. (2012). Analysis of endocrine disrupting compounds, pharmaceuticals and personal care products in sewage sludge by gas chromatography–mass spectrometry, Talanta, 89, 258–263.
[48]. Zhang Z., Le Velly M., Rhind S. M. *et al*. (2015). A study on temporal trends and estimates of fate of Bisphenol A in agricultural soils after sewage sludge amendment, Science of 7e Total Environment, 11(1), 515-516,.
[49]. Zornıkova G., Jarosova A., and Hrivna L. (2014). Distribution of phthalic acid esters in agricultural plants and soil, Acta Universitatis Agriculturae et Silviculturae Mendelianae Brunensis, 59, 233–238.