

**OBAFEMI AWOLOWO UNIVERSITY, ILE IFE,
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**ENDOCRINE DISRUPTORS EVERYWHERE: *HOW
SAFE IS OUR ENVIRONMENT?***

BY

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PREAMBLE

Mr. Vice Chancellor Sir, other Principal Officers of the University, members of the University Governing Council, Distinguished members of Senate, Provosts of Colleges, Deans of Faculties, Directors, Heads of Departments, Great Ife Students, Gentlemen of the Press, Distinguished Ladies and Gentlemen.

I hereby express my deep appreciation to God for the privilege given me to stand before this distinguished audience to deliver today's Inaugural Lecture of the Obafemi Awolowo University (OAU), Ile Ife, Nigeria. Going down the memory lane, today's Lecture is the 6th in the Department of Chemistry; the third in our Environmental Analytical Unit and the 431st in the series of Inaugural Lectures of the Obafemi Awolowo University Ile Ife, Nigeria.

Over six decades now, I was born to Pa Johnson Aderibigbe and Mama Mosunmola Julianah OGUNFOWOKAN, both of blessed memory. My Father was a farmer and later was employed as a Security man in this University on first of April 1976, while my mother was a petty food seller. I am the first of the six siblings of my parents, I attended St. Luke's Primary School Gbogan and finished in 1972 after which I proceeded to Secondary School, in 1973. Due to paucity of funds, I could not continue my education and I had to stay out of School for some years as there was nobody to help and I was deemed never to make it in life. But my father insisted I must go back to school after he was employed here in the then University of Ife. I proceeded to Oluorogbo High School,

Hezekiah Oluwasanmi Road 7 in 1976 and graduated in 1981. I was later admitted to read Industrial Chemistry at the Ogun State University (now Olabisi Onabanjo University), Ago Iwoye. The following year, my second and third siblings were also admitted into the University. This made the journey very rough and tough to the extent that my father had to sell his Suzuki 120 motorbike that he bought, on loan, from this University for four hundred Naira in order to support our university education at the onset. Eventually by His grace, I obtained my first degree in 1987 through thick and thin. Then, the book of Isaiah 60:15 succinctly became manifest in my life: Whereas thou have been forsaken and hated, so that no man went through thee, I will make thee an eternal excellency, a joy of many generations.

Indeed, my standing before this distinguished audience today delivering the 431st Inaugural Lecture is a testament to the life of one not forsaken by God.

After completing the mandatory one-year National Youth Service in 1988, I attended one of our Lecturers wedding ceremony in Abeokuta where I met my mentor- Professor Olalekan Siyanbola Fatoki (then Dr. O.S. Fatoki) by divine arrangement who persuaded me to come to Obafemi Awolowo University for my Master's Degree and I consented. Professor Fatoki then supervised my M.Sc. Thesis titled: 'Determination of Phthalate esters in Surface waters of South Western Nigeria'. Due to the brain drain syndrome of the late 80's and 90's, Professor Fatoki migrated to South Africa, and handed me over to Professor

Francis Olabode Asubiojo for the Supervision of my PhD which I completed in 2000. I am most grateful to the duo for their academic investment in my life.

Mr. Vice Chancellor Sir, this was the beginning of my journey in the world of endocrine disruptors in the environment. As a result of that decision to come to OAU in 1988, I was later appointed Assistant Lecturer in 1993 in the Department of Chemistry, during the tenure of Professor M.S. Akanni as Head of Department and I rose to the rank of Professor of Analytical and Environmental Chemistry in 2010. The prophecy in the book of Isaiah 60:15 that I quoted earlier has been fulfilled in my life. Consequently, I have been able to mentor many successful great men and women in the area of Analytical and Environmental Chemistry.

I had intended to deliver this inaugural lecture a few years ago but life presented a number of challenges along the way. Glory be to God for He makes all things beautiful in His time and so today is the appointed day.

In all these, Mr. Vice Chancellor Sir, I return all glory to God almighty- So then it is not of him that willeth, nor of him that runneth, but of God that sheweth mercy (Romans 9:16 KJV). It is therefore with a grateful heart to God almighty, the giver of knowledge and wisdom that I present this 431st inaugural lecture entitled-‘Endocrine disruptors everywhere- How safe is our environment?’

INTRODUCTION

What are Endocrine Disruptors?

Endocrine disruptors are hormonally active agents that act like hormones in the endocrine system. They are chemicals that may interfere with the endocrine system and produce adverse developmental, reproductive, neurological and immune effects in both humans and wildlife (Bergman *et al.*, 2012). They are found in all physical environments such as air, water and soil (Ogunfowokan *et al.*, 2021). Because of their persistence, propensity for bioaccumulation, and toxicity to humans and ecosystems, endocrine disruptors are part of the many groups of pollutants that have drawn growing scientific attention. They pose serious health risks to humans on exposure, even at low dosage. The Model of the endocrine systems targeted by EDCs is presented in Figure 1.

Classifications, sources and adverse effects of some endocrine disruptors

Endocrine disrupting chemicals can be classified into two: (a) Metals and (b) Trace Organics

Metals

Toxic metals are elements with an atomic number more than 20 that exhibit ductility, conductivity, and ligand specificity and are therefore persistent in the environment because they cannot be broken down (Xin *et al.*, 2022).

Metals such as lead (Pb) are found in paint, inks and dyes, vehicular emission, plastics and chemicals (<http://www.lead.org.au/fs/fst2.html>). Elevated Pb concentrations increase the risk of hypertension and birth defects (Rabinowitz, 1988); causes reduction in the intelligent quotient (IQ) of children (Ogunfowokan *et al.*, 2000; Ogunfowokan and Fakankun 1998).

Cadmium (Cd) is another endocrine disruptor found in mining, burning fuels and phosphate fertilizers. Its adverse effects in humans include pain in bones. It also has mutagenic, carcinogenic and teratogenic effects (Fischer, 1987; Friberg *et al.*, 1986; Heinrich, 1988).

Furthermore, arsenic (As) has been reported to cause decreased in production of red and white blood cells, lung irritation, infertility and miscarriages in women, heart disruptions and brain damage.

Mercury (Hg) is an endocrine disruptor that bioaccumulates in fish. Health effects of Hg poisoning are abdominal cramping, vomiting, kidney and heart diseases.

Figure 2 explains the various Endocrine-Disrupting Heavy Metals, their endocrine disrupting effects and health toxicity on Human Health.

Trace Organics

Trace organic pollutants such as pesticides, phthalate esters, Polycyclic Aromatic Hydrocarbons (PAHs), Polychlorinated

Biphenyls (PCBs), are emerging contaminants that result from industrial operations, agricultural activities, household waste, and plastic usage (Qiu & Hu, 2025). Phthalate esters in particular are components of many consumables (Figure 3). They are not chemically bound to the polymer matrices of the products but are present as a mobile component. As a result, their significant migration into the environment through leaching is inevitable (Fatoki and Ogunfowokan 1993a &b). Apart from phthalate esters, other endocrine disrupting chemicals are: **Bisphenol A (BPA)**, used in food packaging, toys, and other applications (Figure 4), **Atrazine, Dioxins and Perchlorates**. Some common sources of organic endocrine disruptors are presented in Figure 5. The inorganic and organic endocrine disruptors are ubiquitous and are dangerous to human health even at low concentrations, hence the topic of this inaugural lecture ‘Endocrine disruptors Everywhere- How safe is our Environment?’

Some Common Routes of Endocrine Disruptors into Humans

The following are the routes to endocrine disruptors in humans:

- (i). Personal Care Products often contain endocrine disruptors, including but certainly not limited to phthalates. The use of deodorant with aluminum which absorbed through the skin and accumulates in breast tissue where tumors develop;
- (ii). Drinking Water may be contaminated with atrazine, phthalates, arsenic, and perchlorate, all of which may disrupt the endocrine system;

(iii). Indiscriminate Disposal of Wastes- it is very common in this part of the world to dispose-off wastes containing endocrine disrupting chemicals especially plastic materials, polythene bags into flowing rivers through water ways during rainfall (Figure 6). The plastics undergo gradual fragmentation into microplastics through pyrolysis and microbial decomposition which when consumed by fish and other aquatic animals may result in devastating effects on them and eventually on humans' health;

(iv). Wrong cooking methods – Cooking with plastic materials and polythene nylon especially, the cooking of 'moinmoin' (steamed beans pudding) is very dangerous as these wrappers contain some endocrine disrupting chemicals that become leached into our food during cooking and when such food is consumed bioaccumulation and biomagnification of these chemicals in the body could lead to health challenges; and

(v). Kitchen Products- Plastic containers that are common in many kitchens are other sources of EDCs. They may contain phthalate esters, BPA or other endocrine-disrupting chemicals that can leach into food, especially if the plastic is heated.

What is Environment?

The environment encompasses all the chemical, physical, and biological elements that living beings interact with. It is a complex system that includes both natural and artificial elements.

The physical elements include air and atmosphere, water bodies, land and soil, climate and weather; while the biological elements are the flora and the fauna. Human activities in the physical environment significantly impact on the environment, which disrupt the delicate balance of the natural world. This inaugural lecture primarily focuses on my research interest in the physical and biological elements of the environment particularly the endocrine disrupting chemicals.

My Contribution to knowledge

Mr. Vice Chancellor Sir, over the years, my research efforts have contributed to the development of sensitive, environment-friendly and cost-effective methods for the qualitative and quantitative determination of persistent organic pollutants (POPs) including some EDCs in the aquatic and biological samples (Fatoki and Ogunfowokan 1993 a & b; Ogunfowokan *et al.*; 2009; and Adenuga ...Ogunfowokan *et al.*; 2020). These methods have been the foundation upon which many studies have been conducted in my research group to date (Adenuga *et al.*; 2020; Ogunfowokan *et al.*; 2012; 2019; Oyekunle *et al.*, 2011; Olutona *et al.*, 2017).

In order to reduce the menace of EDCs in the environment, my research has helped to develop remediation strategies to clean-up toxic metal and organic pollution in the environment (Fatoki and Ogunfowokan 2002; Ogunfowokan *et al.*, 2007; Awokoya *et al.*, 2024; and Akinjokun *et al.*, 2021, 2023).

Method Development and Determination of Endocrine Disruptors in Aquatic Environment.

Method development and validation is the process of designing procedures to identify, quantify, and characterise substances in samples. It ensures that laboratory procedures produce accurate, precise, and reliable results suitable for regulatory and scientific purposes.

In 1993, we developed a procedural cleanup adsorption technique (Fatoki and Ogunfowokan 1993a) for selective determination of phthalate esters using Gas Chromatograph equipped with Flame Ionization detector (GC-FID). The following analytical procedures (a-c) were followed in the development of the cleanup adsorption technique:

- a. determination of choice of extraction solvent:** The extraction efficiencies for chloroform, dichloromethane and ethyl acetate were investigated for the determination of phthalates in recovery experiments. The study showed that of the several solvents tried for extraction, dichloromethane (DCM) gave the best recovery result (Table 1);
- b. determination of choice of adsorbent for cleanup experiment:** furthermore, in developing the method, we evaluated the possibility of using alumina and silica gel adsorbents for cleanup (Fatoki and Ogunfowokan 1993 a & b) of extract in step ‘a’ above. Our results showed that alumina proved to be a better suitable adsorbent material for cleanup (Table 2); and

c. determination of choice of eluant solvent from adsorption column: several solvents and solvent mixtures were used to elute phthalate esters from alumina column in order to establish the most suitable eluting solvent for the cleanup. Hundred percent (100%) ethyl acetate gave the best recovery results (Table 3).

The developed method was used for routine analysis of phthalate ester endocrine disruptors in aquatic samples.

Routine analysis of water samples

Subsequently, the method described above was tested on water samples collected from seventeen rivers (Table 4) and some tap water samples from Nigerian Southwestern cities' water treatment plant (Table 5). The results showed that the river and tap water samples were grossly polluted with several phthalate esters (Fatoki and Ogunfowokan 1993 a&b). The values reported for these endocrine disrupting chemicals in the surface waters in the study were 10^5 higher than the water criteria limit of $3 \mu\text{gL}^{-1}$ of the US Environmental Protection Agency (USEPA) for the protection of fish and other aquatic life in rivers (USEPA, 1980) and this gives cause for concern.

Mr. Vice Chancellor Sir, it is worthy of note that the above method was developed during my M.Sc. project and was used for the very first time for the selective qualitative and quantitative determinations of phthalate ester endocrine disruptors in water samples from aquatic environment of Southwest Nigeria. The

method was found to be cost effective, sensitive, environment-friendly and reliable for the determination of phthalate esters and other endocrine disruptors in water and wastewater samples from aquatic environment.

As a follow up to our study on phthalate esters in 1993, High-Performance Liquid Chromatography (HPLC) Instrumentation (instead of GC-FID) was employed by Ogunfowokan *et al.* (2006) for profiling levels of seven phthalate ester plasticizers- DMP, DEP, DBP, dioctyl phthalate (DOP), bis(2-ethyl-hexyl) phthalate (DEHP), diphenyl phthalate (DPhP) and diisononyl phthalate (DINP) (Table 6) in wastewater from the OAU Sewage Treatment Oxidation Pond (STOP) and its receiving stream (Figure 7). The results showed high concentrations of the seven phthalate esters in the wastewater from STOP and the receiving stream with the former being higher in phthalates than the latter. The discharge of the effluents from treated wastewater from STOP into the receiving stream led to increase in the concentrations of phthalates downstream and therefore impacted the receiving stream. The levels of phthalate esters reported from the receiving stream were higher than the Suggested No-Adverse Effect Level (SNAEL) of 7.5-38.5 μgL^{-1} for drinking water Ogunfowokan *et al.* (2006). This gave cause for concerns as the peasant farmers downstream use water from the stream to wet their vegetables during dry season. The fish and other aquatic biota in the stream are also at risk of serious health effects due to phthalate esters contamination. It was recommended that urgent action should be

taken by the authority in charge of the OAU STOP to upgrade it to improve its treatment performance.

Polycyclic Aromatic Hydrocarbons (PAHs) in Environmental Samples

Ogunfowokan *et al.* (2003) also carried out some investigations with regards to levels of PAHs in surface runoff and sediments from samples collected close to highways from Lagos, Ile Ife and Osogbo townships. Quantitative analysis of PAHs was carried out using Gas Chromatograph-Mass Spectrometer (GC-MS) at the Department of Chemistry and Biochemistry, Villanova University, Villanova Pennsylvania USA. The surface runoff and its associated sediments of Lagos and Osogbo/Ile Ife areas are quite enriched with PAHs contaminants. Levels of these compounds were relatively higher in sediments than in surface runoff indicating that sediments are sinks for PAHs contaminants. For both matrices, concentrations of PAHs are higher in Lagos study area than Osogbo and Ile Ife due to the higher industrial activities and traffic volume in Lagos.

Endocrine Disruptors in Biological Samples and Medicine

Mr. Vice Chancellor Sir, I have reported some of the endocrine disruptors' studies in environmental samples covering drinking water, surface waters, wastewater, surface runoff and sediments from some parts of the Nigerian ecosystem. This distinguished audience may be wondering: what is the place of endocrine disruptors in Biology and Medicine? I hasten to report Sir, that

these too were not left out in our studies. For over a decade and half now, our efforts in the determination of endocrine disruptors focused on the determination of these pollutants in biological samples. Prior to the studies on biological samples ethical clearance certificates were obtained from the Obafemi Awolowo University Teaching Hospitals Complex Ethics and Research Committee and Institute of Public Health Obafemi Awolowo University and the samples were collected under the supervision of trained medical personnel.

Endocrine Disruptors in Breast-milk and Urine of Lactating Mothers

Phthalates are known hepatotoxins and carcinogens besides being endocrine disruptors with a possible link to adverse reproductive and neuro-developmental outcomes. Their use in diverse personal care products resulted in widespread exposure of the human population, particularly pregnant women and infants. Results of our study showed that concentration of phthalates was about hundred times in breast milk than in urine (Adenuga, *et al.*, 2020) (Table 7). The high levels of phthalates in nursing mothers' breast-milk is an indication of the neonates' exposure to the endocrine disrupting compounds from breast-milk.

Phthalate Esters and Organochlorine Pesticides in Human teeth

Human teeth have the ability to store chemical information over long periods of time, and are becoming regarded as a reliable biomonitoring matrix for measuring long-term exposure to

environmental toxins (Arora *et al.*, 2008). In 2026, my research group have also determined the concentrations of phthalate esters and organochlorine pesticides (OCPs) in human teeth (Figure 10) samples collected from the Dental Clinic of OAUTHC, Ile-Ife, Nigeria (Orimoloye, 2026). The results of the study showed varied concentrations of phthalate esters at higher levels compared with the concentrations of OCPs which were generally below the detection limit in most of the samples analyzed. The low levels of OCPs reported in the study gave no cause for health concern.

Inorganic Endocrine disruptors in Human teeth

Teeth can also serve as reliable indicators for identifying polluted environments concerning heavy metals and nutritional status (Chew *et al.*, 2000) (Figure 10). Dental caries is an oral disease that is globally known to affect individuals of all ages. Many risk factors have been identified in the cause of dental caries such as bad dental hygiene (Arora *et al.*, 2008). Our study on concentrations of trace elements in human carious teeth tissues presented no significant difference in the concentrations of metals with respect to age and sex (Oyebode *et al.*, 2022). The mean concentrations of the elements studied in different parts of teeth- dentin, enamel, and pulp samples showed that pulp had the highest concentrations and served as sink for most of the trace elements in the human teeth studied (Table 8). The study demonstrated that teeth can be very useful in the environmental exposure assessment of trace elements.

Inorganic Endocrine Disruptors in Urine of Patients and Tissues of Human Cadaver

Our preliminary study on inorganic endocrine disruptors- Cd and Pb in urine was conducted twenty-four (24) years ago (Ogunfowokan *et al.*, 2002) during which urine samples of healthy smokers and non-smokers from Ile-Ife were analysed. Our results showed that Cd levels in urine of smokers and non-smokers were higher than the recommended normal level of $0.0085 \mu\text{g mL}^{-1}$, while levels of Pb were above the $0.08\text{-}0.15 \mu\text{g mL}^{-1}$ exposure range. This study therefore provoked our interest in conducting other researches in other biological samples many years after.

In 2008, we carried out a study on endocrine disruptors namely Cadmium (Cd), Lead (Pb) and Mercury (Hg) in kidney and liver from human cadaver in Ile Ife (Ogunfowokan *et al.* 2008). In both kidney and liver, the concentrations of the metals followed the trend $\text{Cd} > \text{Hg} > \text{Pb}$ irrespective of sex and age group. The levels of lead, cadmium and mercury in this study in human kidney and liver are not unexpected as it is known that Cd, Pb and Hg are readily cleared from the blood and accumulate in the kidney and liver which contain approximately two-thirds of the total body burden (Al-Saleh and Al-Doush 1996). Human beings are exposed to these metals by ingestion and inhalation through breathing and dermal routes (Ogunfowokan *et al.*, 2008; Adesiyan *et al.*, 2018; Sabine and Wendy, 2009).

Furthermore, Ogunfowokan *et al.* (2019), determined the concentrations of some heavy metals in urine samples of patients with kidney, liver and lung related diseases between ages 15 and 70 years. The urine and tissue samples were digested using microwave assisted digestion method prior to AAS analysis. Our choice of microwave assisted digestion (MAD) (Figure 11) was because it is cost effective, provides high pressure/temperature aggressive digestion of samples with excellent recovery for multi-elemental analysis at much lesser time compared to the hot open beaker plate digestion method that we used in our earlier study in 2008. Our results showed that the concentrations of Cd and Pb which are endocrine disruptors in urine samples of patients diagnosed with liver, lungs and kidney related diseases (such as Lupus Nephritis, Pulmonary tuberculosis, Induced Liver Cirrhosis, Hepatocellular Carcinoma) in male and female patients were higher than those of the control samples and also higher than the standard human urine levels of metals recommended by World Health Organization irrespective of sex and age group.

Results of the analysis of the tissues from human corpses showed that high concentrations of Mn were recorded for kidney, liver and lung samples for both male and female corpses while Pb had the lowest concentrations. The study concluded that the high concentrations of heavy metals obtained in the urine samples confirmed the associated health complications recorded for the patients.

Endocrine disruptors in ‘Pure Water’

Mr. Vice Chancellor Sir, for many years, there was a campaign in Nigeria, focusing on health for all by the year 2000 in accordance with WHO's directives. With respect to water supply, the objective was to ensure that potable water was available in the home or within 15- minutes of walk from home. The high demand for 'pure water' as a matter of necessity gave a boost to the 'pure water' industry at that time as reflected in the number of 'pure water' manufacturers springing up indiscriminately in most communities, more so that potable water was not easily within the reach of many.

Our research group was the first to present preliminary results of elemental and microbial analyses of commonly sold Nigerian 'pure water' (now called 'Sachet water') which was generally believed to be pure (Ogunfowokan *et al.*, 2000). An estimation of concentrations of trace elements including arsenic and lead and total bacterial count were performed on the 'pure water' samples for proper assessment of the hazards associated with their intake when compared with WHO standards for drinking water. The concentrations of essential elements were within the WHO safe limits. However, there was violation of WHO limit of 0.05 mg/L for arsenics and 0.1 mg/L for lead in all the 'pure water' samples. Results of total bacteria count for all the pure water samples except two samples exceeded the NAFDAC accepted standard value of 100 cfu/mL. It was obvious from the results of our preliminary study that the risk factors in the potability of the 'pure water' samples are more than what can be overlooked and we

concluded that it was not likely that we have safe potable water for all by the year 2000.

Mr. Vice Chancellor Sir, our study generated special national interest and concern so much that two Nigerian National News Papers published the results of our preliminary study in *The Guardian* (February 6, 2000) captioned as ‘Pure Water or Poor Water?’ and in the *Nigerian Tribune* (February 17, 2000) captioned as “‘Pure water’ contains cancerous substance”.

As it stands today, twenty-six (26) years after our preliminary study, availability of potable water in the home or within 15 minutes of walk from home is still a mirage.

Endocrine Disruptors in Blood of Pregnant Women

In collaboration with colleagues in Obstetrics and Gynecology Department at OAUTHC, we documented the levels of Calcium, Cadmium, Copper, Iron, Magnesium, Manganese, Nickel, Lead and Zinc in the blood of pregnant women (Yahaya *et al.*, 2014). We reported that variation in the concentrations of the trace metals body burden varied with age, education and profession of the subjects. Our results indicated that there was no serious metal body burden on the pregnant women and also that there was no cause for concern especially for the fetuses.

Endocrine Disruptors in Confection Wrappers

Safe and nutritious food packaging is very important in our society not only to ensure that food gets to its consumer in good condition but also to conserve and preserve it. Nowadays,

industrialists are using different colourful packing materials to make their products attractive to the consumers without bordering about the problem of food contamination Hankin *et al.* (1974). Consequent on the above, Ogunfowokan *et al.*, 2005 analysed different brands of biscuit and sweet wrappers purchased from different supermarkets from southwestern Nigeria for the levels of lead and cadmium in them. Our results showed that concentrations of lead were generally higher compared with cadmium for both sweet and biscuit wrappers. The presence of lead in our study was frequently associated with yellow and/or orange pigments in the studied wrappers. Lead in blood as low as 10 mgdL^{-1} may be harmful to growing children (Ogunfowokan *et al.*, 2005).

Some other organic and inorganic endocrine disrupting chemicals that have been studied in environmental samples in my research group apart from those described above are already well documented in different Scientific Journals (Oyekunle.... Ogunfowokan *et al.*; 2011; Ogunfowokan *et al.*; 2012; Olutona...Ogunfowokan *et al.*, 2017; Oyekunle.... Ogunfowokan *et al.*, 2026 and Fagbemi, Ogunfowokan.....*et al.*, (2024 a&b).

Remediation strategies for clean-up of Endocrine Disruptors in the Environment

Environmental remediation is a multifaceted process of removing pollutant or contaminants from environmental media with the

aims of restoring an affected site to a condition safe for humans and ecological health, and suitable for its intended future use.

Mr. Vice Chancellor sir, so far, I have described in this Lecture some modest contributions and discoveries in my odyssey in the world of endocrine disruptors. Apart from providing a better understanding of the occurrence and health effects of EDCs it is imperative to also provide information on our efforts towards curtailing and avoiding their occurrence in an ecosystem.

In 2007, Ogunfowokan *et al.*, carried out a comparative study on removal of heavy metals-Cr, Cd, Ni, Pb, Mn and Zn from industrial wastewaters using local alum and other conventional coagulants. Wastewater samples from battery, paint and textile industries were treated with different doses (mgL^{-1}) of locally available alum, and conventional aluminum sulphate and ferric chloride coagulants in order to determine and compare their effectiveness in removing heavy metal contents from the wastewaters. Our study showed that the percentage removal of the metals from the industrial wastewaters increased with mgL^{-1} dosage of the coagulants with optimal performance generally at a slightly alkaline pH of 7.5 (Table 9a and 9b). Local alum, in addition to its usefulness in removing turbidity from wastewater, proved to be cheap and equally effective in the removal of heavy metals from industrial wastewater samples compared with the conventional aluminum sulphate and ferric chloride coagulants. Local alum may therefore be used as a substitute to the conventional coagulants.

The remediation of wastewater from trace organics was carried out in 2024 by my research group (Awokoya *et al.*, 2024), during

which series of styrene-divinyl based Molecularly Imprinted Polymers (MIPs) were synthesized and characterised using dibutyl and diphenyl phthalate as templates with bulk polymerization method for the remediation of phthalate contaminated wastewaters of environmental importance. The MIPs synthesized were first characterized using the XRD, SEM and FTIR (Figure 12). The designed experiments were carried out to explore the adsorption thermodynamics and kinetic isotherms. The MIP adsorbents gave excellent di-butyl phthalate (DBP) and di-phenyl phthalates (DPhP) adsorption efficiencies that exceeded ninety percent (90%). The study showed that the pseudo-second order kinetic model (Table 10) was more consistent with our experimental data which was well explained by Langmuir isotherm model, suggesting homogeneous surface of the adsorbent. The calculated thermodynamic parameters showed that the adsorption process was mainly spontaneous and endothermic in nature with favourable adsorption efficiencies at elevated temperatures. The study further showed that the MIPs are of great stability which show no adsorption efficiency loss even after seven (7) runs of regenerated cycle (Figure 13a) and was therefore considered and used as excellent sorbents with potential for complex wastewater treatment. The synthesized MIPs (MIP_{DBP} and MIP_{DPhP}) were finally applied to the real samples of industrial dumping ground and river wastewaters (Figure 13b) and showed that MIPs could be effectively used as sorbents for real sample analysis with considerable reusability. The study demonstrated that endocrine disruptive chemicals could be effectively removed from polluted aqueous environmental samples by imprinted materials.

My Opportunities, Teaching, Research and Administrative Experience

Mr. Vice Chancellor Sir, the three functions of an academic are: Teaching, Research and Community Service. In the area of teaching, I have taught many generations of students. Among them, in addition to Chemistry graduates, are those who have gone on to specialize in diverse fields. Quite a few of such former students are even in this audience today both online and onsite. Many of them are now Professors, Associate Professors and Lecturers in their different disciplines.

In the area of research, I have made frantic efforts to expand the frontiers of knowledge by publishing a total of three (3) Book Chapters and eighty-three (83) peer reviewed articles in high Impact Factor Journals. My Google Scholar Citation is 2662, h-index, 28 and i10-index 50.

Besides teaching, I have been privileged to mentor and supervise more than 150 undergraduate dissertations, sixteen (16) M.Sc., five (5) MPhil and thirteen (13) PhD Theses and I am still counting. Five (5) of my former PhD and M.Sc. students are today full Professors they are John Oyekunle, Adetutu Okoya, Yahaya Mounsor, Godwin Olutona and Adeniyi Adenuga while two of them are Associate Professors namely Funminiyi Obisanya and Omolara Fagbemi. To the glory of God, they are occupying important positions within and outside this University.

My opportunities

Mr. Vice Chancellor Sir, I have had some opportunities and training that impacted my career positively. I am therefore grateful to the Obafemi Awolowo University Administration for the great opportunities granted me during my academic journey. Between 1990 and 1992, I was awarded Obafemi Awolowo University, Postgraduate fellowship- A teaching Assistantship Fellowship of three thousand Naira only per annum. In 1994, I was awarded the World Bank Staff Development Project Fellowship to complete my PhD bench work utilised at Villanova University, Villanova, Pennsylvania, United States of America. After the completion of my Ph.D. in 2000, I won the South Africa National Research Foundation (NRF) Post-Doctoral Award utilised at Forth Hare University, Alice, Eastern Cape, South Africa.

In the year 2011, I participated in the National training in Distance Learning, organised by the British Council in conjunction with the National Universities Commission and United Kingdom Open University and was awarded a certificate as a National Trainer in Distance Learning. Furthermore, between March 2015 and June 2016 I represented OAU as one of the seven Nigerians that were trained and Certified as Internal Quality Assurance Manager by DAAD, HRK, DIES (Germany), NUC Nigeria and National Accreditation Board Ghana. I was awarded research grant jointly with Professor Olayinka Ogunkoya by the United Nations University Institute for Natural Resources in Africa (UNU/INRA)

in 2003 and also the Merged 2021-2023 Tetfund Institutional Based Research Grant (IBR).

I facilitated the utilisation of SEANAC and OPCW awards for majority of my postgraduate students which enabled them to complete their bench work abroad and hence finished their programmes in record time.

Mr. Vice Chancellor Sir, University administration is one area in which I have built some capacities. I have served in most strata of the university system in my thirty-three (33) years as a scholar. Within the Department of Chemistry, I served in different committees and was appointed Head, Department of Chemistry from 2012-2015.

Furthermore, I have served the Faculty of Science OAU in different capacities too numerous to mention here. It is worthy of note that I was elected the 19th Dean of Faculty of Science Obafemi Awolowo University (OAU), Ile Ife, Nigeria (2015-2017).

Within the University, I served as Associate Staff, Institute of Ecology OAU (1999-2007). I was a Representative of Dean, Faculty of Science at the Faculty of Social Science selection panel and review panel. I was appointed Lecturer, Distance Learning, Obafemi Awolowo University Pre-Degree Programme; served as member of the search team for the appointment of a new Vice Chancellor, Obafemi Awolowo University, Ile-Ife, in 2011; Chairman, Parents Teachers' Association of International School,

Obafemi Awolowo University (OAUIS), Ile-Ife, Nigeria (2012-2016); and President Awovarsity Cooperative Investment and Credit Society Limited (2022-2024).

Outside the University I have served and still serving as External Examiner, for the B.Sc., MSc, PhD degree programs in numerous universities both onshore and offshore. I am an External Assessor for Professorial Chairs to many Universities in Nigeria and abroad.

I am the current national president of the old students' association, Oluorogbo High School, Ile-Ife, and the current Chairman, Governing Board of New Covenant Church Bible College, Nigeria.

I was appointed during my approved leave by the pioneer Vice Chancellor, First Technical University, Ibadan (Now Abiola Ajimobi Technical University) Professor Ayobami Salami as the Pioneer Dean of Faculty of Natural Sciences (2017-2019). During this period, I assisted in laying a solid foundation for the Industrial Chemistry program which the university has successfully built on till today. I was elected Member of Council, First Technical University, Ibadan Oyo State, Nigeria (2018-2020). I was also appointed as the Vice Dean of Postgraduate School during my one-year sabbatical leave visit to University of Medical Sciences (UNIMED), Ondo City, Ondo in 2025. During this period, I chaired an ad-hoc committee that produced the university's postgraduate guidelines and forms for the use of postgraduate school and students to ease the processing of their postgraduate matters. Furthermore, I also successfully supervised one M.Sc. Student in the area of Forensic Chemistry in the Department of Chemistry at UNIMED.

I was appointed Guest Editor, Toxicological and Environmental Chemistry Journal, Taylor and Francis UK in 2009. I am a reviewer to many Scientific Journals both Locally and Internationally. I served as Editor-in-Chief for *Ife Journal of Science* (2017-2021). The Journal made significant academic impact and received contributions from eminent scholars across Nigeria and abroad. The Journal had since been Published online by African Journal Online (AJOL) to date.

I was elected as Secretary, Chemical Society of Nigeria (Osun State Chapter) from 2007 to 2011. I served as Secretary, Local Organizing Committee of the 1st Annual International Conference of the Chemical Society of Nigeria, Osun State Chapter in 2008 and lately Chairman, Local Organizing Committee of the 48th Annual International Conference, Workshop and Exhibition of the Chemical Society of Nigeria in 2025, during which about one thousand chemists attended and participated. In the year 2025 I was honored with the prestigious Fellowship of my professional body-the Chemical Society of Nigeria as Fellow of Chemical Society of Nigeria (FCSN).

Summary and Recommendations

Summary

Mr. Vice Chancellor Sir, my voyage in the world of endocrine disruptors has been very fascinating and eventful. In the past thirty-three (33) years as an academic and researcher, I have developed some environment-friendly and cost-effective analytical methods for the qualitative and quantitative

determination of endocrine disruptors in different environmental matrices such as drinking water, surface waters, surface runoff, waste waters from Industries and sewage treatment oxidation ponds, sediments, soils and biological samples. Endocrine disruptors are indeed everywhere!

Our results showed that the endocrine disruptors were detected in the environmental and biological samples in varied degrees. In biological samples we have been able to relate the high concentrations of heavy metals in the urine samples of Hospital patients to their associated health complications. Our study on human teeth, demonstrated that teeth can be very useful in the environmental exposure assessment of trace elements. The high levels of phthalate esters in nursing mothers' breast-milk was an indication of the neonates' exposure to the endocrine disrupting compounds from breast-milk. Results of potentially toxic metals reported in the blood of pregnant women indicated no serious metal body burden on the pregnant women and gives no cause for concern especially for the fetuses.

Generally, the levels of the endocrine disruptors in both biological and environmental samples are not completely safe for humans' health, hence the title of this lecture- 'Endocrine disruptors everywhere- How safe is our Environment?

In order to maintain clean environment our team has been able to formulate some remediation strategies for clean-up of the endocrine disrupting chemicals in the Environment in order to

reduce their negative impacts on humans and aquatic biota and to make our environment safe.

Recommendations

Mr. Vice-chancellor, we need a lot to do individually and collectively in order to reduce the impacts of endocrine disruptors in our environment: First, our leftover foods should be stored in glass or ceramic containers instead of in plastic containers. We should desist from microwaving foods stored in plastic containers. Reheating such food in earthenware on stove is the best practice.

Second, let us all imbibe the age-long practice of cooking our ‘moinmoin’ (steamed beans pudding) using ‘eweeran’ leaves (*Thaumatococcus daniellii*) instead of using plastic materials and polythene nylon.

The use of natural and/or homemade personal care products such as shear butter mixed with olive oil helps a lot in preventing EDC exposures. The use of deodorant with aluminum should be discouraged.

In addition, products that come in glass bottles and jars are safer than products in plastic or cans. Furthermore, we need to avoid the use of fabric softeners as much as possible because such products place petrochemicals directly in contact with the skin. All manners of pesticides, herbicides, insect repellants and weed killers are harmful when kept in the house. Moreover, it is dangerous to drink uncertified sachet water, tap water containing

excessive chlorine and other chemicals. We should instead drink bottled ozonized water from reputable sources. Also, the habit of drinking from water bottles left in hot cars should stop immediately.

We should all monitor our children to ensure they do not chew on plastic toys, sweet and biscuit wrappers. We should always keep trash out of drainages to save lives because blocked channels cause flooding and disease outbreaks.

Finally, there is urgent need for government to update environmental laws in our country and improve on the enforcement strategies of the existing laws. This is because there is an increasing burden of disease across the globe, in which EDCs are likely playing an important role due to their indiscriminate use. Future generations will be affected if nothing is done to stop this menace.

Appreciation and Acknowledgements

First and foremost, I have to express my gratitude to God almighty and my Redeemer who makes it possible for me to deliver this 431st Inaugural Lecture. My Hallelujah belongs to Him.

Mr. Vice Chancellor Sir, it will be immoral of me to claim all the credits for the modest contributions expressed in this lecture. Permit me to quote the Warri, Nigerian Pidgin proverb which is often quoted by my very good friend- Professor Isaac Adewale ‘monkey sabi jump, na because tree near tree’ meaning that a

person's success, skill, or boldness often depends on the favourable environment or support system they have. Obafemi Awolowo University over the years has given me the academic platform upon which I am standing today. I thank the University for allowing me to train, develop and grow to the peak of my career as a professor. Consequent to my training at OAU, the products of my research are very conspicuous globally and are cited all over the world. I am grateful to colleagues in the Faculty of Science under the leadership of our current Dean, Professor O.A. Adesina for your support always and for creating the healthy atmosphere in which we are all working.

I acknowledge the guidance, thorough supervision and immense contributions of all my supervisors from undergraduate to postgraduate levels. Special thanks to my undergraduate supervisor and teacher- Venerable Samuel Olusegun Onafeso, the Chief Resident Minister, Chapel of the Healing Cross, Idi Araba, Lagos. I have an extraordinary intellectual and personal indebtedness to my M.Sc. supervisor- Professor Olalekan Fatoki who introduced and baptised me into the world of endocrine disruptors. To my Ph.D. Supervisor, Emeritus Professor Olabode Idowu Asubiojo, thank you for believing in me and for accepting to supervise me when I became fatherless academically. I also thank Professor Joe Foley and members of his research group at Mendel 305 laboratory, for providing me with bench space to finish my PhD research work at Villanova University, Villanova USA. Big thanks to my collaborator, Professor Nelson Torto of

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To my collaborators in the College of Health Sciences OAU, Nigeria- Professors Bode Balogun, Department of Medicine, Kayode Adelusola, Olutoyin Omoniyi-Esan, Akinwumi Komolafe of Morbid Anatomy and Forensic Medicine, Ernest Orji of O&G, Ebunoluwa Adejuyigbe of Department of Pediatrics and Child Health, Babatunde Aregbesola, Elizabeth Osiegbe and Tope Esan of Faculty of Dentistry, I say a big thank you.

I acknowledge the dedication of, and support received from all members of Academic and Non-Academic Staff of Chemistry Department OAU, students and mentees too numerous to mention during my sojourn in the world of Endocrine Disruptors. Special thanks to Professor John Oyekunle for your cooperation and commitment to learning and support in my research group.

Great thanks also to all members of the planning committee for this inaugural lecture. I thank you all and others who supported this inaugural lecture financially and those who reviewed the manuscript of this lecture- Professors Olaosun, Lukman Olasunkanmi and Emeritus Professor Olabode Asubiojo. You are all wonderful and amazing. My inability to mention every name here is regretted even though your reward from the Almighty God is certain.

I appreciate my primary, secondary and A' Level school Teachers who inculcated in me the spirit of hard work and molded my life in those formative years. I also appreciate my mates from Oluorogbo High School, Ile Ife those present here in this hall and those present online.

I also appreciate the following listed special friends and senior colleagues from within OAU and other Nigerian universities FUNAAB, UNILAG, UI, EKSU, UNIMED, OOU, TECH-U and BOWEN. I thank you all.

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Ogunjimi, Bukky Oyeboade, Biodun Adeoye (Abiola Ajimobi Technical University), thank you all for the pioneering work we did together at Tech-U.

I acknowledge the good will I have enjoyed from the following Vice Chancellors: Professors Ayobami Salami, Pioneer VC of First Technical University for inviting me to build the new University with him and for giving me the opportunity to be appointed the First Academic Dean of the University, and subsequently elected as a council member of the prestigious university; Adesegun Fatusi, (UNIMED) who also appointed me as the Vice Dean of Postgraduate School of his University during my Sabbatical leave; Jonathan Babalola (BOWEN) and Taiwo Asaolu (UNILESA) for their support in cash and kind to Chemical Society of Nigeria when OAU hosted the International Conference last year for which I served as Chairman Organising Committee. I want to appreciate Professor ‘Sola Ajayi, the Current Vice Chancellor, Abiola Ajimobi Technical University for the good work we have done together during the early stage of the University.

I am deeply indebted to my lovely parents, Mr. Johnson Aderibigbe Ogunfowokan and Mrs. Mosunmola Ogunfowokan, both of fond memories. I appreciate the sacrifices you made for me and my siblings in ensuring our academic success and moral upbringing. I acknowledged my parents-in-law Mrs. Martha Modupe Osokoya, and late Mr. Johnson Adekunle Osokoya, thank you for your prayers and for releasing your amazing

daughter for me as wife. To all my beloved siblings-Bamidele Adesoji, Oluwagbemiga Olatubosun, Modupeoluwa Oluwayombo, Abayomi Adekitan, Adetoun Esther, their spouses and children I am blessed to have you all as my first dependable friends. My warm gratitude goes to my siblings' in-love- Sunday, Sesan, Dayo, Taiwo and Kehinde Osokoya and spouses for your love and support to my family.

I appreciate the leadership of New Covenant Church for the platform given me to fulfill my ministry in Christ. My heartfelt thanks go to Rev. (Dr.) Paul Jinadu (General Overseer) and his wife, Rev. Emmanuel Ajao (Associate General Overseer), Rev. and Rev. Mrs. Olufemi Oyelade (Deputy General Overseer) and Rev. and Rev. Mrs. Abimbola Oladipo (National Overseer), Rev. Femi and Rev. Professor Funmi Soetan and all the Conference Pastors, members of governing board and management team of Bible College New Covenant Church, Nigeria for your leadership, friendship and discipleship that has enriched my walk with the Lord in my spiritual journey. I equally appreciate the entire congregation and pastoral team, of New Covenant Church Ile-funfun and Osu Centres comprising of- Rev. Professor and Rev. Mrs. Olukayode Ajayi, Rev. and Rev. Mrs. Ogie Omoba, Rev. and Mrs. Rufus Ayoola, Papa Ade Adepetu of blessed memory and Mrs. Fola Adepetu, Dr. and Bar. Mrs. Ade Adegbami, Mr. and Mrs. Alaba Akinsehinde, Mr. and Mrs. Lawrence Eluwami and all pastors of the entire Ile-Ife Conference

of New Covenant Church for which I have the honour and privilege to serve as Satellite and Conference pastor respectively.

This lecture will not be complete without a special mention of my loving, caring and hard-working wife, Professor Adesola Adenike Ogunfowokan Nee Osokoya. Thank you for loving me with everything you have and for being my pillar of support now and during my adventure into the world of Endocrine disruptors. You are indeed a jewel of inestimable price. Today, is an eloquent testimony of the wisdom of being joined to the same garment of a woman supernaturally endowed with wisdom, vision, grace and passion. Your sacrifices and the peace of mind you give me have made it possible for me to stand before this distinguished audience to deliver this Inaugural lecture.

I sincerely appreciate our children, who are of great blessings, Ibukunoluwa Daniel, Oluwaferanmi Emmanuel and Ireoluwa Eunice. Thank you for always making us proud.

Mr. Vice Chancellor Sir, Distinguished audience, there is no better way to end this 431st Inaugural Lecture than chorusing the following song which I request you all to please join me in singing:

Oba alanu mi
Oloore atodun modun
Eyin Lo too lati gba ogo
E ku itoju mi
Oloore atodun modun
Eyin Lo too lati gba ogo

Mr. Vice Chancellor Sir, other principal officers of the University, Colleagues, gentlemen of the press, ladies and gentlemen, thank you for your attention. God bless you all.

It pays to serve Jesus!!!!