UNIVERSITY OF ILORIN

THE TWO HUNDRED AND SIXTY-SECOND (262ND) INAUGURAL LECTURE

"THE SOJOURN OF A PHYSICAL ENVIRONMENTAL CHEMIST EXPLORING ENVIRONMENTAL IMPACT IN THE LIFE OF MAN"

By

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DEPARTMENT OF CHEMISTRY,
FACULTY OF PHYSICAL SCIENCES,
UNIVERSITY OF ILORIN, NIGERIA

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The Vice-Chancellor

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All other Academic Colleagues,
Non-Teaching Staff,
My Lords, Spiritual and Temporal,
Distinguished Students of Chemistry,
Esteemed Invited Guests,
Gentlemen of the Press,
Great Students of the University of Ilorin,
Distinguished Ladies and Gentlemen.

Preamble

'Authubillahi minna Shaetani Rajeem Bismillahi Rahmani Raheem"

I seek refuge in Allah against the accursed devil. I begin the delivery of this inaugural lecture in the name of Allah, the Beneficent, the Merciful. Allah, You are the Omnipotent and the Omnipresent, the First and the Last, the beginning and the end. It is with much gratitude to the Almighty Allah that I am here today, before this distinguished audience from far and near to deliver the 262nd inaugural lecture of this great citadel of learning, the University of Ilorin, which is the 11th from the Department of Chemistry; coming thirty-six years after the first one was delivered by Prof. M. O. Fagbule, on "Colour for a Colourless World: A Chemist's Modest Contribution". The tenth was delivered by the Chief Imam of the University, Prof. N.

Abdus-Salam on “Pollution: A Curse or a Necessity, the choice is yours”. The details of the first ten inaugural lectures delivered from this Department are presented in Table 1.

Table 1: Details of the previous ten (10) inaugural lectures delivered from the Department of Chemistry

University number	**Depart-mental number**	**Inaugural Lecturer**	**Title of the inaugural lecture**	**Date of delivery**
32nd	1st	Prof. M. O. Fagbule	Colour for a Colourless World: A Chemist’s Modest Contribution	15th December, 1988
75th	2nd	Prof. J. A. Obaleye	Marriageology of Chemical Nature: Drug – Metal Complexes Perspective	29th July, 2004
82nd	3rd	Prof. Sulyman A. AbdulKareem	Making Stuffs, Hot Stuffs: The Power of Mind over Matter	10th May, 2007
84th	4th	Prof. S. A. Ibiyemi	Thevetia Plant Economic Potentials: Chemistry’s Key Position	28th June, 2007
88th	5th	Prof. G. A. Olatunji	Journey to the Promise Land: The Travails of an Organic Chemist	12th February, 2009
125th	6th	Prof. D. S. Ogunniyi	My Adventure with Polymers	21st March, 2013

130th	7th	Prof. F. A. Adekola	The Hearth of Science in Service of Man	25th April, 2013
138th	8th	Prof. E. O. Odebunmi	Catalysis and Chemical Industry Development: A Fruitful Wedlock	21st November, 2013
165th	9th	Prof. U. B. Eke	In Search of the Answers to Questions Unknown	24th November, 2018
226th	10th	Prof. N. Abdus – Salam	Pollution: A Curse or a Necessity, the choice is Yours	2nd February, 2023

An inaugural professorial lecture is a milestone in the life of any University through which the Administration brings town and gown together at an open academic gathering to celebrate an appointment to professorship. In the University of Ilorin, such a lecture is delivered by tenured faculty members who have attained full professorial status, within the stipulated years of their professorial promotion with the dictate of the appointment letter. The presentation of an inaugural lecture is a significant event in the academic career of a professor where past research is shared and new ideas are introduced to a diverse audience. This can lead to new collaborations, strengthened existing relationships, and a positive impact on industrial stakeholders and policymakers.

Today, 11th July, 2024; I am humbled, honoured, privileged and highly grateful to deliver the 11th Inaugural lecture of the Department of Chemistry and the 262nd inaugural lecture of the University. It is the **first** inaugural lecture that focuses on Physical Environmental Chemistry within the Department of Chemistry to be delivered by the privileged **First Female** Professor and **First Female** Head of Department of this great Department of this University. This lecture entitled "The

Sojourn of a Physical Environmental Chemist Exploring Environmental Impact in the Life of Man" is coming two years, nine months after my appointment as a Professor of Chemistry, which is within the timeframe stipulated in my appointment letter. I am indebted to the Vice – Chancellor, Prof. Wahab Olasupo Egbewole, SAN and his administration for this rare opportunity.

Introduction

My life journey can be described as a series of chemical reactions in which Allah used many courteous individuals to serve as catalysts to speed up the processes. My primary education started from Sacred Heart Convent School, Idikan, Ibadan, Oyo State (Girls only) where I spent only 2 years of my early life. From there, I proceeded to Ebenezer Primary School at Oke – Ado, where I started with morning school. Shortly after one year, the Government granted two sessions, morning and afternoon, and gave parents the option to choose which session their wards attended (1976). While my siblings were allowed to attend morning sessions, my Grandma, late Wulemotu Olalounpe Asake and my Mum, late Wasilat Odunola Aduke (who died in January this year; may their souls rest in perfect peace) insisted that my Dad place me in the afternoon session due to my dutifulness, so that I could continue running market errands at Orita Merin (for pepper) and Agbeni (for provisions) early in the morning. I would return before 11:00 am, and then leave for my afternoon school. At school, we always opened our daily activities with mental sums (multiplication Table and day-to-day arithmetic) – kudos to my primary four to six teachers, (Mr. A. Olahan, Mrs Olashehinde and others); may God continue to be with them and their families – to which I can attribute the mathematical prowess which was acknowledged by my subsequent teachers at St. Teresa's College (1980-1986). This led them to persuade and encourage me towards pursuing Mathematics or Mathematics-related programme. By destiny, I however, find myself in the volatile field of Physical Environmental Chemistry, which is also Mathematics related.

Journey into Physical Environmental Chemistry

Three JAMB Examinations (1984, 1985 and 1986) were written by me and the scores were always two hundred and forty-five (245). At every attempt, I was offered Chemistry instead of medicine which was my interest, so I decided to proceed to do ‘A’ Levels at Queen School, Ibadan. I completed the programme with nine (9) points, and I was again offered Chemistry via Direct Entry. I also declined because my interest at that time was staunchly Medicine. I sat for another JAMB and I was again offered Chemistry. At this point, I was advised to take it as destiny by my Dad with the encouragement that my late uncle, Prof. Suara Adedeji Adediran – who studied and was teaching Chemistry at the time, and whose footprint I later met at the Department of Chemistry and was doing well in life. While I was not too happy, I grudgingly accepted and made fundamental vows not to stop till I reached the pinnacle and attain the status of a “Doctor”.

Mr. Vice-Chancellor, the journey began as an undergraduate student in the Department of Chemistry, University of Ibadan, with my interest deepening in abstract/theoretical Chemistry, despite the original medical dream. I eventually worked under the tutelage of late Prof. Idowu Iweibo, who also died recently, may his soul rest in peace. My undergraduate project was on ‘Caging effect of Benzene and its halo derivatives’. When I returned for my Masters’ Degree, and he asked me how many compounds I worked with during the undergraduate days to which I responded with an affirmative 5 and he said that “it is not possible”. Then, I asked why? He answered by asking the question: ‘Is it possible I gave you more than one compound? I answered ‘yes’, and I brought out my project; then he said if that is the case, I should think of an electron withdrawing group and put it on benzene, to have a new compound. Another question followed: Nike! the name of the compound? I paused and responded, ‘Toluene’ he shouted “brilliant”! and he continued, “you are to study the microscopic properties (dipole moments and polarizabilities) of your choice halo-derivatives of that compound”. It was during the course of my masters' that there was the ASUU strike of 1992, which started on the day we were to start our second Semester Examination, and led to its indefinite postponement. I decided to use the opportunity to get married. While plans had been put in place to hold the ceremony on the 17th October, 1992, the ASUU strike was abruptly called off and the postponed examination was rescheduled for Monday, 19th October, 1992. While there was initial dilemma of how to combine the wedding ceremony with preparations for the examination, I look back today with gratitude because of the success of the wedding and the examination. In fact, my M.Sc. research work was later published in a highly rated Iranian Journal (**Abdul Raheem *et al.*, 2010**).

I came to University of Ilorin in search of Medicinal Chemistry, to diversify from theoretical Chemistry, unfortunately I was told the only Professor in the department with interest in the field, Prof. J. A. Owoyale, was late. While my mind was made up on diversification from theoretical Chemistry, I enquired about other options, and was later admitted to a Ph.D. programme in "Environmental Chemistry". The Ph.D. began in earnest with retired Prof. S. A. Lawani (thank you sir, for agreeing to supervise me then). I started the work and the design was to work on Air Pollution Chemistry. As the work began in 1999/2000, the pregnancy I had waited over six years for, which made me delay commencement of Ph.D. ventured my way. While the journey was long and arduous, I sincerely appreciate Prof. I. O. Oloyede who was the then Director of Academic Planning (DAP), for his efforts at ensuring my studentship was not terminated due to issues attributable to pregnancy complications. My supervisor retired after a few years and I was allocated to Prof. F. A. Adekola. We had to rework the Ph.D. which warranted collaboration with Dr. I. B. Obioh of Atmospheric Research and Information Analysis Laboratory (ARIAL), Centre for Energy Research and Development (CERD), OAU, Ile-Ife, a Physicist. As my Ph.D. sojourns required that I periodically be in Ife, I had to rely on my community for support, which saw my new supervisor and few other colleagues take up the responsibility of caring for my children in my absence. I eventually won Global Change System for Analysis Research and Training, START's $24,000 scholarship which facilitated the purchase of needed materials to assist the research work, and which other research students are using to date. While on the programme in 2004, I joined the service of LAUTECH as an Assistant Lecturer, the same job and position that I was offered in 1993, when I finished my Masters which I had to decline due to marital obligations. The Ph.D. was ultimately completed to the glory of Allah, with its benefits continuing to be evidenced as I forge ahead in life.

On completion of the Ph.D. in 2007, I wrote to the University for permission to carry all equipment and other materials to LAUTECH where I was working based on the agreement on the scholarship, and as Allah will have it, I was ultimately offered a Lecturer II position under the Vice-Chancellorship of Prof. S. O. O. Amali and retired Prof. E. O. Odebunmi as HOD. The rest, they say, is history.

Mr. Vice-Chancellor, my M.Sc. was in Physical Chemistry at the University of Ibadan while my Ph.D. was in Environmental Chemistry at the University of Ilorin. Vice-Chancellor sir, what follows is the account of my research in Nigeria and abroad in the last thirty –four years.

Physical Chemistry

Physical Chemistry is a branch of chemistry that deals with the study of how matter behaves on a molecular and atomic level, as well as the principles that govern these behaviours. It combines principles of physics and chemistry to understand the properties and behaviour of matter and energy in chemical systems. Physical chemists use mathematical and computational tools to describe and predict the behaviour of chemical systems. This field encompasses various sub-disciplines such as thermodynamics, quantum mechanics, molecular spectroscopy, electrochemistry and kinetics (Encyclopedia Britannica, 2019).

Physical Chemistry seeks to explain the fundamental physical and chemical properties of matter and the interactions between molecules. It explores phenomena such as chemical reactions, phase transitions, and the behaviour of materials under different conditions. This branch of chemistry is essential for understanding and designing processes in fields like materials science, chemical engineering, and biochemistry (Atkins and Paula, 2018). Physical Chemists utilise experimental techniques and theoretical models to elucidate the mechanisms behind chemical processes (McQuarrie *et al*., 1997). In Physical Chemistry, researchers investigate the microscopic behaviour of atoms and molecules to explain macroscopic properties of matter, such as temperature, pressure, and concentration. This field is interdisciplinary, drawing from physics, chemistry, mathematics, and computational science to address complex chemical problems. Through experimentation and theory, physical chemistry aims to deepen our understanding of chemical systems and contribute to advancements in technology and industry (Levine, 2008). Overall, physical chemistry serves as a bridge between the macroscopic world of everyday experiences and the microscopic realm of atoms and molecules, providing insights into the fundamental principles that govern chemical systems. It is a dynamic and evolving field that continues to push the boundaries of our understanding of matter and energy (Moore *et al*., 2012).

On the other hand, Environmental Chemistry is the scientific discipline that explores the chemical processes occurring in the environment, including air, water, soil, and living organisms, and their effects on ecosystems and human health. It investigates the sources, transport, transformation, and fate of chemical substances in the environment, as well as their interactions with natural and anthropogenic factors. Environmental Chemists analyse pollutants, contaminants, and natural substances to assess their impact on environmental quality and develop strategies for pollution prevention and remediation. This field integrates principles from chemistry, physics, biology, geology, and environmental science to address complex environmental challenges such as pollution, climate change, and resource management (www.acs.org/ content/acs/ en/greenchemistry/research-innovation/researchtopics/environm ental-chemistry.html).

Environmental Chemistry plays a crucial role in understanding and mitigating the impact of human activities on the environment, including pollution from industrial processes, agriculture, and waste disposal. By studying the behaviour of chemicals in different environmental compartments, environmental chemists contribute to the development of sustainable practices and policies for environmental protection and conservation (Baird and Cann, 2012). Environmental Chemistry encompasses a wide range of research areas, including atmospheric chemistry, aquatic chemistry, soil chemistry, ecotoxicology, and biogeochemistry, each focusing on specific environmental compartments and processes. Through fieldwork, laboratory experiments, and modeling studies, environmental chemists strive to unravel the complex interactions between natural and anthropogenic chemicals in the environment. This interdisciplinary field draws upon knowledge from chemistry, biology, physics, and engineering to address environmental issues at local, regional, and global scales (Manahan, 2016).

Environmental Chemistry aims to provide a comprehensive understanding of the chemical composition and behaviour of environmental systems, enabling informed decision-making and effective management of natural resources. It seeks to identify emerging environmental contaminants and understand their potential risks to ecosystems and human health (Brimblecombe and Hiroshi, 2012). In summary, Environmental Chemistry is the interdisciplinary study of chemical processes in the environment and their impact on ecological systems and human well-being. By applying chemical principles to environmental problems, environmental chemists contribute to the sustainable management and protection of natural resources for future generations (VanLoon and Duffy, 2010).

Physical Environmental Chemistry, an emerging specialisation, is the interdisciplinary study of the chemical processes occurring in the environment, focusing on understanding the physical and chemical properties of natural systems and their interactions with pollutants and contaminants. It combines principles from physical chemistry and environmental science to investigate the behaviour of chemicals in various environmental compartments such as air, water, soil, and living organisms. This field seeks to elucidate the mechanisms driving environmental phenomena, including pollution, climate change, and ecosystem dynamics, through experimental and theoretical approaches. By integrating knowledge of chemical kinetics, thermodynamics, and transport processes, Physical Environmental Chemists develop strategies for environmental monitoring, remediation, and sustainability (www.acs.org/content/acs/en/greenchemistry/research-innovation/research-topics/environmental-chemistry.html; and Atkins and Paula, 2018).

Physical Environmental Chemistry plays a crucial role in addressing contemporary environmental challenges, such as air and water pollution, global warming, and depletion of natural resources, by providing insights into the fate and behaviour of pollutants in the environment. Through the application of analytical techniques, computational modeling, and laboratory experiments, researchers in this field aim to develop solutions for minimising the environmental impact of human activities and promoting sustainable development (Baird and Cann, 2012; McQuarrie and Simon, 1997). By integrating physical chemistry concepts with environmental science principles, Physical Environmental Chemistry offers a holistic understanding of the complex interactions between natural and anthropogenic chemicals in the environment. This interdisciplinary approach allows for the quantification and prediction of environmental processes, facilitating evidence-based decision-making and policy development for environmental management and conservation. (Manahan, 2016; and Levine, 2008).

In summary, Physical Environmental Chemistry is the study of chemical processes in the environment, emphasizing the physical and chemical aspects of environmental systems and their responses to natural and human-induced changes. By employing a multidisciplinary approach, Physical Environmental Chemists contribute to our understanding of environmental issues and strive to develop innovative solutions for a sustainable future (VanLoon and Duffy, 2010).

My Contributions to Knowledge

Microscopic Properties -Role of electrons in compounds

Chemistry is about the complete study of matter, while matter can be defined as anything that has weight and can occupy space, meaning everything that man can see including man can be referred to as matter. To understand the complexity of matter, properties of matter are needed. Dalton, a great scientist established that atom is the smallest particle of an element. This was later corrected when it was realised that an atom is made up of three particles, positively charged (+); negatively charged (-) and neutral particle (0). The basis of matter is, therefore, an atom containing the three particles which when combined, form small molecules and can later recombine to form giant molecules, formation of life. Chemistry looked into properties of matter and classified them into two: microscopic and macroscopic. Microscopic are properties of atoms that are minute which cannot be seen or felt (e.g. electron properties, internal heat, dipole moment, polarizability etc) but can be inferred from the macroscopic properties of molecules (e.g. temperature, pressure, volume etc). On these intrinsic properties, the whole world seats.

Electronic Absorption

Vice-Chancellor sir, **Abdul Raheem *et al.* 2005** studied the solvents and substituents effects on the electronic absorption spectra of toluene, and some of its halo-derivatives. Solvent and substituent effects on the electronic absorption spectra properties of benzene, toluene, m-fluoro, p-bromo, p-chloro and o-bromo toluene (Figure 1) have been investigated. It was found that the introduction of the halide substituents into the skeletal structure of toluene (parent compound) causes red shift (bathochromic effect) in the frequencies of transition due to their possession of pair of electrons i.e. (Auxochromes). The magnitude of the red shift of each substituent follows the order: Br >Cl > F in all the bands, although slightly affected by the position of these halogens as expected from the electronegativity and molecular mass of these atoms. Polar solvents also shift the wavelength of absorption maxima to the red relative to non-polar solvents thus revealing that the observed three bands belong to Π Π* transition, differentiate between allowed and forbidden transition and compare the relative charge densities of the structures of the compounds in the ground and excited states. It was discovered that the halides are inductively electron withdrawing. However, because of their ability to donate a lone pair of electrons in resonance forms, they are activators and undeviating in ortho/para direction.

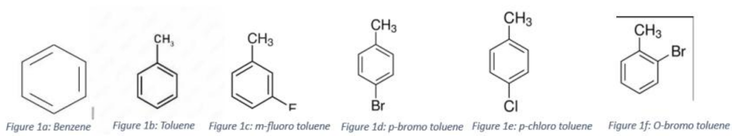


Figure 1: Structures of benzene, toluene, m-fluoro, p-bromo; p-chloro and o-bromo toluene

We decided to apply the theory of substituent's effect to study the effect of alkyl group content on the standard affinity of an acid dye on nylon 6 fibre (Bello, Peters, Nkeonye, Sunmonu and **Abdul Raheem, 2005b**). Knowing theoretically that the standard affinity of a dye for a given substrate has a fundamental effect on dying properties of such substrate, the standard affinities of four acid dyes on nylon 6 fabric were determined spectrophotometrically. It was observed that the average standard affinity of the acid dyes increases per methylene group and the value obtained was 1.28 kJ per mole from the plot of standard affinity against number of carbon atoms of the alkyl group present in dye structure. From the results obtained, it can be suggested that the size of the alkyl group in a dye molecule affects the standard affinity of the fiber for the dye at a particular temperature. It is therefore, possible to predict from a thermodynamic point of view, the degree of exhaustion of a particular dye based on the ability to calculate the standard affinity from the main structure with respect to the alkyl chain length attached to the main structure, when there is only one sulphonic acid group. The results, by this trend, can be used to predict the exhaustion of a particular dye on nylon 6 fabric to a reasonable accuracy.

In 2010, we resolved to verify the theory reported on halides that they inductively donate lone pair of electrons in resonance forms, thereby becoming activators in ortho/para direction by looking into the ultraviolet-visible (UV) spectra of toluene, ortho-bromo and para-bromo toluene in different solvents. The electric dipole moments and polarizabilities in the molecular excited electronic states of these compounds were determined (**Abdul Raheem *et al*., 2010**). It was discovered that the electric dipole moments for the excited states (μ*) and the ground states (μ) of these compounds are equal (Table 2), and the change in dipole moment is zero (Table3). This implies, in part, that there was little or no change in potential energy surfaces of the ground and the excited states. The negative values obtained for the change in polarizabilities (Δα) for the Lb state in various transitions (Table 3) indicated contraction in the excited state relative to the ground state, because the polarizability is proportional to the molecular volume, the study sheds light on the intricate interplay of electronic properties in aromatic compounds like toluene and its derivatives **(Abdul Raheem *et al*., 2010).**

Table 2: calculated Ionization potentials, dipole moments, polarizabilities, approximate (spherical) radii and wave number of the 0-0 electronic transitions of selected bands of the compounds **(Abdul Raheem *et al*., 2010)**

Parameter (Unit)	**Benzene**	**Toluene**	**P-bromo toluene**	**O-bromo toluene**
1011I(erg)	1.41296	1.41296	1.38413	1.37721
υv (cm^{-1})	38089	37484	36263	36174
108 ru(Å)	2.86789	2.86789	3.05749	3.05744
1024α(cm^3)	10.546	12.174	15.231	15.231
μ(D)	0.0	0.0	0.0	0.0

Table 3: Excited state electric dipole moment, polarizability and ionization potentials of the Compounds **(Abdul Raheem *et al.*, 2010)**

Compounds	**Change in dipole Δμ(D)**	**Polarizability α* (Å^3)**	**Change in polarizability Δα* (Å^3)**	**Ionization potentials 10^{12}(ergmol^{-1})**
Benzene	0.0	7.593	-2.953	7.23115
Toluene	0.0	8.888	-3.286	6.62676
4-bromotoluene	0.0	9.090	-3.966	6.62676
2-bromotoluene	0.0	11.842	-3.389	6.58673

Chemical Kinetics and Environmental Studies

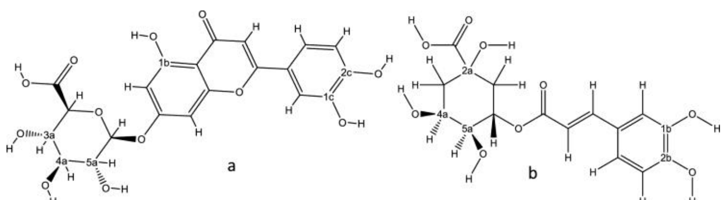
Chemical kinetics is the study of reaction rates, the changes in the concentrations of reactants and products with time. With a discussion of chemical kinetics, the reaction rates or the changes in the concentrations of reactants and products with time are studied.

In other to use Chemistry in making the environment clean through the use of agricultural waste materials, Mr. Vice-Chancellor, Yusuff, **Abdul Raheem**, Mukadam, and Akerele (2018) researched into biosorption of Cr (III) ions from aqueous solutions by groundnut husk, a low-cost biosorbent on a laboratory scale batch experiment. The effects of pH, contact time, particle size, biosorbent dosage and temperature on the adsorption of Cr (III) ions were investigated. The results showed that the biosorption of Cr (III) ions from aqueous solution by groundnut husk is a spontaneous process with a ΔGo value of -24.38 kJmol^{-1} at 298 K and follows the pseudo second order kinetics with a rate constant of 0.0151 min^{-1}. The results indicated that groundnut husk can be employed as a low-cost alternative to commercial adsorbents in the removal of Cr (III) ions from wastewater to further sort removal of harmful substances from wastewater before it is released into water bodies to save the environment and aquatic lives.

Yusuff, **Abdul Raheem**, and Agboola (2019a) investigated the adsorption of indigo blue dye from aqueous solution onto coconut shell, a low-cost agricultural waste material in a batch process. The results revealed that percentage of the indigo dye adsorbed from aqueous solution varied linearly with the adsorbent dose, concentration and time with maximum percentage dye adsorption of 88.4 % at 70 mg dosage, 95.8 % at 0.05 mg/L concentration and 90 % at 1 hr contact time but varies non-linearly with pH and maximum percentage dye adsorption of 92.9 % attained at pH of 5. The adsorption equilibrium data were analysed with Langmuir, Freundlich and Temkin isotherm models with the Langmuir isotherm having the best fit to the adsorption process with R^2 value of 0.998. The experimental data were best described by the pseudo-second order kinetics model. FTIR analyses revealed that the adsorption process was through a chemical interaction of the dye with some functional groups at the surface of the adsorbent. The chemically modified coconut shell is an effective adsorbent for the removal of indigo dye from aqueous solution.

Kinetics of Antioxidant activities, Docking and DFT

Density Functional Theory (DFT) is one of the most frequently used computational tools for studying and predicting the properties of isolated molecules, bulk solids, and material interfaces, including surfaces, although the theoretical underpinnings of DFT are quite complicated. In a simple definition, docking is a molecular modeling technique that is used to predict how a protein (enzyme) interacts with small molecules (ligands).



(a) Luteolin-7-O-β-glucuronide and (b) chlorogenic acid
Yusuff, **Abdul Raheem**, Mukadam and Sulaiman (2019b)

Figure 2: Structures of Luteolin-7-O-β-glucuronide and chlorogenic acid

The docking process involves two basic steps: prediction of the ligand conformation, its position and orientation within these sites (usually referred to as pose) and assessment of the binding affinity. Vice-Chancellor sir, Yusuff, **Abdul Raheem**, Mukadam and Sulaiman (2019b) equally researched into Kinetics and Mechanism of the Antioxidant Activities of *Corchorus olitorius* (*C. olitorius)* and *Vernonia amygdalina* (*V. amygdalina)* by Spectrophotometric and DFT methods. This was about investigation on the kinetics of the 2,2-diphenyl-1-picrylhydrazyl (DPPH) radical scavenging activities of two vegetable leaves extracts.

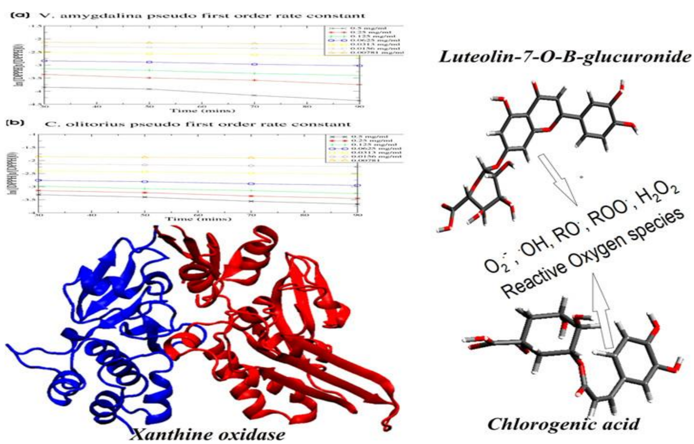


Figure 3: Pictorial summary of the research

It was discovered that both plants exhibited second-order kinetics, favoring this mechanism over pseudo-first order kinetics. *V. amygdalina* demonstrated faster DPPH radical scavenging with a second-order rate constant of 1 min^{-1} (k_2 = 0.0152 mM^{-1}) compared to *C. olitorius* (k_2 = 0.0093 mM^{-1}). The predominant phenolic antioxidants in both plants are chlorogenic acid and luteolin-7-O-β-glucuronide oxidase, these compounds preferentially scavenge the DPPH radical through a hydrogen atom transfer mechanism. Their lower bond dissociation enthalpy values support this mechanism, indicating efficient radical scavenging. Successful molecular docking of these phenolic compounds revealed favorable interactions with the therapeutic target, xanthine (Figure 3). “The Sojourn of a Physical Environmental Chemist Exploring Environmental Impact in the Life of Man”.

Contributions to Knowledge in the area of Environmental Chemistry

Our environment is a hugely complex system that includes the air we breathe, the land we live on, the water we drink and the climate around us. We must work to ensure that our development in some areas do not adversely affect our environment whilst also ensuring that we mitigate any damage that has occurred. Work by some researchers (Rockström *et al., 2009*) has shown that we are already at a tipping point that might lead to “non-linear, abrupt environmental change within continental- to planetary-scale systems”. The good news is that politicians globally are looking at how to solve this problem of environmental pollution. The United Nation’s (UN) Sustainable Development Goals include universal calls to action to protect life on land, and in water, producing clean water and tackling climate change. Meanwhile, the European Union’s (EU) Environmental Action Plan includes nine priority objectives that aim to ensure “we live well, within the planet’s ecological limits”.

As we strive towards a better world, we work to ensure chemistry’s contributions are realized. Chemistry can help us to understand, monitor, protect and improve the environment around us. Chemists are developing tools and techniques to make sure that we can see and measure air, water and soil pollution. They have helped to build the evidence that shows how our climate has changed over time. And they can be part of the efforts to understand and address new problems that we face like microplastics and the potential effects of the different chemicals that we are exposed to (rsc.org).

Vice-Chancellor sir, we contributed to monitoring air, water and soil in Nigeria to know the extent of pollution by comparing the data achieved with baseline data. This will aid the government's intervention to mitigate against pollution on land, water and air which aligns with the UN sustainable development goals; 3, which is good health and wellbeing; 6, which is clean water and sanitation; 11, which is sustainable cities and communities; 13, which is climate action; 14, which is life below water and 15, life on land.

Air is a mixture of gases and particles, some of which are reactive and undergo complex chemical reactions in the atmosphere to form air pollutants such as ozone. Other air pollutants are emitted directly - for example, sulphur dioxide. Air pollutants can be solid, liquid or gas and come from natural and man-made sources; the biggest contributors to air pollution today are power stations, road transport, industry and residential burning of fuels. Sulphur dioxide was monitored and determined in the atmosphere of Ilorin city, Nigeria during dry season. SO_2 levels were found to significantly vary based on traffic density and human activities. There was a significant difference in SO_2 concentrations between high traffic volume areas and low traffic volume areas. However, there was no significant difference between high traffic/medium population density and medium traffic/high population density areas. Regression analysis revealed a strong correlation ($r = 0.94$) between the concentration of SO_2 and the hourly average traffic volume across all sites. The average SO_2 level in Ilorin city during the study period was 59.3 ± 1.9 ppb (parts per billion). This falls within the limits set by the United States Environmental Protection Agency guidelines for air quality standards. SO_2 pollution is known to inhibit photosynthesis in both lower and higher plants. It has been associated with reproductive disorders, respiratory issues, and cardiac problems in humans. SO_2 is also a major contributor to acidic rainfall, which can damage vegetation and materials. Overall, addressing SO_2 emissions is crucial for maintaining air quality and minimising health and environmental risks. The study underscores the importance of monitoring and managing air pollutants in urban areas like Ilorin (**Abdul Raheem *et al*., 2006**).

Mr. Vice-Chancellor, in 2009, we decided to modify and validate the improvised sampling equipment (Figure 4 and 5) after the grant of START, USA with the receipt of LaMotte air sampler (Figure 6) from United Kingdom. It was discovered that for high precision and reproducibility of results, the volume of absorbing solution must depend on the volume of the volumetric flask used in standards preparation. The results showed that flow rate should be regulated between 1-2 litre(s) per minute while the duration for sampling should be between 30-60 minutes i.e. the higher the concentration of pollutants to sample, the lower the time of sampling. The time between sample collection and analysis should be between 4-8 hours while NO_x samples should not exceed 4 hours. The samples should be kept in dark and refrigerated/ice cooled as soon as they are collected before analysis. To avoid loss of samples during collection, the sampling train should be made airtight. During validation, comparative measurements of SO_2 showed that there exists some agreement between LaMotte and improvised high volume sampler results. However, when measuring NO_x and O_3, improvised high volume sampler exhibits higher sensitivity compared to LaMotte sampler (**Abdul Raheem *et al*., 2009a**).

Abdul Raheem *et al.* (2009b) researched into seasonal variation of the concentrations of ozone, sulphur dioxide and nitrogen oxides in two Nigerian cities. We looked into the implication of atmospheric photochemistry on these gaseous pollutants over Ilorin and Lagos cities. The study focused on two cities: Lagos (located in the coastal area with high congestion due to marine, vehicular, and industrial activities) and Ilorin (a medium-sized town in the central guinea savannah zone of Nigeria).

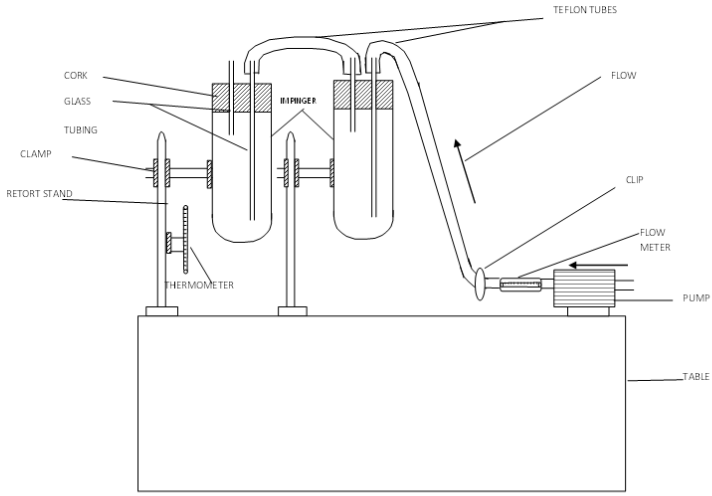


Figure 4: Sketch of proposed Sampling Train for Concurrent Sampling of ozone and NOx **(Abdul Raheem *et al.,* 2009a)**

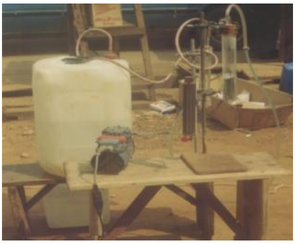
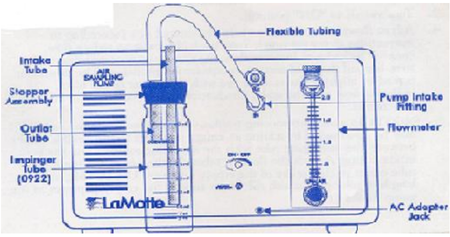


Figure 5: Picture of the Sampling Set-Up **(Abdul Raheem *et al.,* 2009a)**



European Union (EU) (EEA, 2006)	100-150 / 38.2- 57.3 40 – 60 / 15.3- 22.9	24hr 1yr
U.S.A (USEPA, 1997)	364 / 139 78 / 29.8	24hr 1yr
Nigeria (FEPA, 1991)	260 / 99.3 26 / 9.9	1hr 24hr
Japan (EPA, 1986)	104 / 39.7	24hr
UK (World Resources, 1988-89)	266 / 101.6	15 min
Ibadan (Onianwa *et al*., 2001)	34.1 / 13 (mean)	1 hr
Pakistan (Ghuari *et al*., 2007)	137.42/52.5	1 hr
Ilorin (Abdul Raheem *et al*., 2009c)	11.12 / 4.25(mean)	1 hr
Central Berlin (World Resources, 1988-89)	120 / 45.8 (mean)	1yr

Figure 6: Lamotte Air Sampling Set-Up **(Abdul Raheem *et al.*, 2009a)**

Samples were collected during both wet and dry seasons from 2003 to 2006. We employed multivariate statistical methods, including factor analysis, principal component analysis (PCA), principal component regression, and multiple linear regression (MLR). PCA revealed distinct groupings during the day, reflecting different factors contributing to the atmospheric chemistry of these cities. MLR was used to predict ozone concentrations based on meteorological parameters (relative humidity, air temperature, sun exposure) and precursor pollutants. Ozone concentration was influenced by weather conditions and anthropogenic activities. Reduction in nitrogen dioxide (NO_2) levels was associated with an increase in ozone levels, suggesting interconversion between the two via photochemical activity. High ambient air ozone levels can cause health hazards such as shortness of breath, nausea, eye and throat irritation, and lung damage.

Our findings contributed valuable insights for regional air quality control strategies and highlights the importance of understanding pollutant sources and their impact on human health (Table 4). Mr. Vice-Chancellor, all things being equal, if the scenarios painted in our model remain, we have contributed four predictive formulae (equations 1 – 4) (**Abdul Raheem *et al.*, 2009b)** to the pull of knowledge on the management of atmospheric air shed of Ilorin and Lagos during the dry and wet seasons:

Dry season Ilorin: OX = 169.26 + {- 5.33 X ATEMP + 3.98 X SUNEXP} ± 14.03 (1)

Wet season Ilorin: OX = -186.23 + { 1.28 X RHUM + 5.54 X WNDS + 0.289 X WNDD + 1.62 X SUNEXP} ± 2.57 (2)

Dry season Lagos: OX = - 8.79 X WNDS + {1.68 X ATEMP + 5.622 X SUNEXP} ± 3.56 (3)

Wet season Lagos: OX = -736.37 + {3.61 X RHUM + 4.74 X WNDS – 0.38 X WNDD + ATEMP} ± 1.61 (4)

The PCR results revealed the effects of SO_2, NO_2, and meteorological parameters on the ozone level. The dependence on SO_2 has been attributed to the vehicular emissions as the common source and the main contributor to the NO_2 and SO_2 levels in the ambient environment. It gives understanding in terms of the precursor role, while MLR produces better understanding for the effects of meteorological variables. With the monitoring done consecutively for 3 years covering the two seasons and the data generated subjected to spatial and temporal assessments to have the results which provided estimate of the mean concentrations of sulfur dioxide day time trend over Ilorin air shed (Table 4). Results confirmed that the technique could be used to obtain useful information to support air quality management decisions, as well as in-depth understanding of source strengths and potential impacts (**Abdul Raheem *et al.*, 2009c).** Vice-Chancellor sir, as our team's interest in gaseous pollutants in the atmosphere continues, we measured the ozone air quality standard over Lagos air shed as 47.14 μgm^{-3} over 1 hr average (**Abdul Raheem *et al.*, 2012**). In 2017 through 2019, we equally provided estimates of the mean concentrations of two trace gases, day-time trends and the potential contributions to the atmospheric photochemistry in the city's air-shed. Results showed colorimetric / spectrophotometric technique could be used to obtain results needed to support air quality management and some level of understanding of the source strengths, air-shed photochemistry and potential impacts.

In particular, it has been confirmed that NOx plays a strong precursor role in the formation of surface O_3 in the city. It is also established that some weak correlation exists between NOx and traffic density for high traffic-medium population density and medium traffic-high population density sites, while being anti-correlated with traffic for the industrial area-low traffic sites. Indications are that the early morning peak is most likely dominated by NO emissions, which become photochemically transformed in the late morning and afternoon to NO_2. For O_3, it is demonstrated that there is an inverse-correlation between O_3 concentrations and traffic density during daytime. The O_3 values reduce towards zero value during the hours when the sun is switched off, which clearly indicate the strong influence of solar radiation in the photochemistry of O_3 formation (**Abdul Raheem *et al*., 2013**). The observed profile as expected should be strongly correlated with the trends in surface penetration of solar radiation. It is observed that solar radiation penetration to the surface is minimum during the Harmattan season when the atmospheric aerosol content reaches maximum values and minimum during seasonal transitions between Harmattan to Rain (March) and Rain to Harmattan (November) (**Abdul Raheem *et al*., 2017 and Abdul Raheem *et al*., 2019).**

Figure 7: Single open bucket sampler (ASTM D1739, 2010; Nwosu, **Abdul Raheem** and Shehu, 2016)

Vice-Chancellor sir, we equally evaluated some Heavy Metals loading in Dust Fall of Three Universities Motor Parks in Western Nigeria (Nwosu, **Abdul Raheem and** Shehu, 2016). Dust fall samples were collected using an open bucket sampler designed by the team (Nwosu, **Abdul Raheem and** Shehu, 2016 (Figure 7)) based on ASTM D1739 of 1998 (2010) over a period of five months, from November 2014 to March 2015. A 0.1 g dust sample was digested with a mixture of HNO_3, $HClO_4$, and HF in a ratio of 3:2:1, respectively. Heavy metals (Mn, Cu, Zn, Cd, Pb, and Ni) were analysed using an atomic absorption spectrophotometer. Concentrations of heavy metals varied across the three university motor parks: **University of Ibadan**: Mn: 1479.75 $mgkg^{-1}$; Zn: 1255.68 $mgkg^{-1}$; Pb: 241.50 $mgkg^{-1}$; Ni: 128.00 $mgkg^{-1}$; Cu: 85.25 $mgkg^{-1}$; Cd: 9.63 $mgkg^{-1}$. **University of Ilorin**: Mn: 1145.75 $mgkg^{-1}$; Zn: 797. $mgkg^{-1}$; Pb: 219.63 $mgkg^{-1}$; Ni: 133.51 $mgkg^{-1}$; Cu: 58.25 $mgkg^{-1}$; Cd: 23.13 $mgkg^{-1}$; **Kwara State University**: Mn: 778.5 $mgkg^{-1}$; Zn: 323.88 $mgkg^{-1}$; Pb: 259.38 $mgkg^{-1}$; Ni: 101.38 $mgkg^{-1}$; Cu: 34.38 $mgkg^{-1}$; Cd: 4.63 $mgkg^{-1}$. Overall, the heavy metal concentrations decreased in the following order: Mn > Zn > Pb > Ni > Cu > Cd. Notably, Cd and Pb concentrations exceeded the Romanian standard threshold limit, while Ni concentrations were higher than the USEPA values (75 $mgkg^{-1}$). Our study underscores the importance of monitoring and managing heavy metal pollution in urban environments, especially around motor parks.

Vice-Chancellor sir, in the quest for "The Sojourn of a Physical Environmental Chemist Exploring Environmental Impact in the Life of Man", Bloss, Alam, Rickard, Hamilton, Pereira, Camredon, Muñoz, Vázquez, Alacreu, Ródenas, Vera and **Abdul Raheem** (2013) studied the oxidation of volatile organic compounds (VOCs) that led to formation of ozone and SOA, with consequences for air quality, health, crop yields, atmospheric chemistry and radiative transfer. Observations have identified Methyl Chavicol ("MC": Estragole; 1-allyl-4-methoxybenzene, $C_{10}H_{12}O$) as a major Biogenic volatile organic compound (BVOC) above pine forests in the USA, and oil palm plantations in Malaysian Borneo. Palm oil cultivation, and hence MC emissions, may be expected to increase with societal food and biofuel demand. Experiments were performed in the EUPHORE facility (Figure 8) in Spain, monitoring stable product species, radical intermediates, and aerosol production and composition. We determined rate constants for reaction of MC with OH and O_3, and ozonolysis radical yields. Stable product measurements (FTIR, PTRMS, GC-SPME) are used to determine the yields of stable products formed from OH and O_3 initiated oxidation, and to develop an understanding of the initial stages of the MC degradation chemistry. A surrogate mechanism approach was used to simulate MC degradation within the master chemical mechanism (MCM), evaluated in terms of ozone production measured in the chamber experiments (Figure 8), and applied to quantify the role of MC in the real atmosphere.

Figure 8: EU-PHORE Facility **(**Bloss, Alam, Rickard, Hamilton, Pereira, Camredon, Muñoz, Vázquez, Alacreu, Ródenas, Vera and **Abdul Raheem**, 2013**)**

Mr. Vice-Chancellor, we investigated both in-vehicle and ambient pollution levels resulting from vehicular emissions along the Ilorin-Lagos highway (**Abdul Raheem *et al.*, 2019c**). The research covered three distinct 3-hour periods (morning, afternoon, and evening) during the day (from 7.30 am to 6.30 pm). In addition, we examined reported health challenges faced by commuters at six settlements (SP1-SP6) that spanned four states. Our findings were SO_2 concentrations ranged from 0.142 to 0.550 parts per million (ppm) in the ambient air and 0.037 to 0.097 ppm inside the vehicles using MSA detectors. CO concentration varied between 2.289 and 18.055 ppm inside the vehicles. In-vehicle pollution was studied under two conditions: opened-window conditions, the concentration levels for CO and SO_2 inside vehicles were 6.32 ppm and 0.126 ppm, respectively. Under closed-window conditions (without air conditioning), the levels increased to 9.53 ppm for CO and 0.274 ppm for SO_2. Our results when compared with Standards showed that SO_2 concentrations (both ambient and in-vehicle) exceeded the standards set by the Federal Ministry of Environment or NESREA and the United States Environmental Protection Agency (USEPA). CO levels inside vehicles were below the limits set by the National Environmental Standards and Regulations Enforcement Agency (NESREA) and USEPA.

We equally looked into the traffic volume and emissions; statistical evidence indicated that traffic volume significantly affected pollutant concentrations at most sampling points. Higher traffic correlated with increased emissions and a higher risk of health challenges. In summary, our results highlighted the importance of monitoring vehicular emissions and their potential health impacts (**Abdul Raheem *et al*., 2019c**).

Vice-Chancellor sir, in a related study along Ilorin-Oshogbo, **Abdul Raheem *et al*. (2019d)** discovered in-vehicle exposure concentrations (measured with an Altair-5X MGD) ranged as follows: NO_2: 90–1270 μgm^{-3}; SO_2: 124–810 μgm^{-3}; CO: 3262–23800 μgm^{-3}. Cars had the highest average in-vehicle exposure: NO_2: 426±109 μgm^{-3}; SO_2: 571±61 μgm^{-3}; and CO: 10433±1650 μgm^{-3} whereas in ambient air, pollutants mean concentrations of NO_2 and SO_2 exceeded the 1-hour averaging time-limit set by the Federal Environmental Protection Agency (FEPA) but were within the limit set by the Environmental Protection Agency (EPA) while the mean concentration of CO fell within the minimal limit stipulated by the World Health Organization (WHO). AQI ratings for NO_2 and SO_2 ranged from "good" (A) to "hazardous" (F) across sampling points. CO had an AQI rating of F. Our questionnaire results indicated health risks related to pollutant exposure for commuters and other road users. This confirms that clean air remains crucial for human health, and addressing air pollution is essential to prevent associated health risks.

Abdul Raheem *et al*. (2019e) evaluated the pollution levels in the Iponri-Alaka Canal. We investigated various contaminants, air quality, water quality parameters, and their impact on the environment and human health. The pH, TS, DO and TH were well within the WHO and FEPA maximum limits. EC, SO_4^{2-} and TDS were observed to be higher than guideline values only at one sampling point. The TSS, BOD, TA, NO_3^- and PO_4^{3-} were higher than WHO and FEPA guideline limits at all sampling points. Cr was seen to be within, while Pb and Mn were higher than WHO and NESREA guideline values. Cd was higher than guideline values only at two sampling points. Ni was below detection concentration at all the sampling points. The concentration of SO_2 was seen to be higher than WHO and NESREA guideline values at sampling points A and B, but within the limits at C and D. H_2S concentration was higher than

WHO limit at all the sampling points. Cough, poor breathing, chest pain, headache and respiratory tract infections were reported by residents in the area. It is very clear that addressing environmental pollution is crucial for sustainable development and the well-being of communities. However, we submitted that further research and effective management strategies are essential to mitigate the adverse effects of pollution in water bodies like the Iponri-Alaka Canal.

Indoor Air Quality

Indoor air is essential, so its quality cannot be compromised. Hence, Vice – Chancellor sir, we also assessed indoor gaseous air pollutant concentrations from sources in thirty-three residential kitchens within the 4-zone of Ilorin-South Local Government, Kwara, Nigeria. The work focused on SO_2, NO_2, and CO emissions concentration quantification, determination of the air quality index (AQI), estimation of health assessment risk, and deduction of their health implications on the residents. The concentrations of NO_2 and SO_2 were determined by the Saltzman's method using a Gilair-3 air sampler, while the concentration of CO was determined using an MSA Altair-5x multigas detector. Three types of eleven kitchen environments each (kitchens where liquefied petroleum gas (LPG), charcoal, and firewood were used as fuel sources) were considered. The concentrations of NO_2, SO_2, and CO were higher in kitchens that used charcoal and firewood. Although these air quality standards have been established for urban and rural indoor pollution, higher concentrations of these pollutants affect the lungs, which cause chronic obstructive pulmonary disease (COPD), chronic bronchitis, adverse reproductive outcomes, and pregnancy-related problems; such as stillbirth, low birth weight, and lung cancer, as reported in the literature. Finally, gaseous pollutants are more prevalent in households that use firewood and charcoal for cooking, where space confinement, non-cross ventilation, and other unsafe activities within and around the home contribute to the increase in pollutant concentrations. It is recommended that households that use charcoal and firewood should use clean and environmentally friendly fuel (fuel with less or no emission of pollutants), while all cooking activities should always be done in a well-ventilated environment. Providing orientation to residents on modalities should be encouraged, especially in rural areas, on how to reduce exposure to pollutants. The model indicated that the concentrations of the pollutants in the evening, irrespective of the sampling points, were higher than those in the morning. Firewood contributed significantly more than charcoal and LPG ($p<0.05$). The results of the health assessment risk showed that the risk estimated for normal exposure to the pollutants in all the households studied revealed a hazard quotient of <1.0 except for SO_2 from firewood for infants and children = 1.09. The AQI results showed the worst health conditions for households that used firewood (0.103–4.760 ppm NO_2; 0.327–0.647 ppm SO_2; and 12.30–57.83 ppm CO). The study concluded that the use of LPG should be preferred as a source of fuel for cooking (**Abdul Raheem *et al*., 2022**).

Abdus-Salam, Awoyemi and **Abdul Raheem (2016)** looked into comparative studies of water and sediments qualities of some dams in Kwara state. Dams investigated were Agba, Igbaja, Oloru and Omu-Aran. Only Cd and Fe concentrations exceeded WHO guidelines, likely due to anthropogenic input. The dams' sediments were also examined for heavy metals. Manganese (Mn), Zinc (Zn), and Cadmium (Cd) were found to be high in the sediments. These metals can potentially leach into the water body, posing risks to consumers. The study highlights the importance of monitoring water quality in dams. It serves as a baseline data for future research and management efforts. While most parameters met safety standards, vigilance is necessary to prevent contamination and ensure safe water supply from these dams in Kwara state.

Vice-Chancellor sir, Adekola, Inyinbor and **Abdul Raheem (2012)** studied the Heavy Metals Distribution and Speciation in Soil around a Mega Cement Factory in North – Central Nigeria by exploring the surface and sub-surface soils in the vicinity of an ultra-modern and largest cement factory in Nigeria as at then. The study examined five geochemical fractions: exchangeable, carbonate, Fe-Mn oxide, organic matter, and residual and analysed the concentrations of lead (Pb), copper (Cu), zinc (Zn), manganese (Mn), and iron (Fe) using atomic absorption spectrophotometry. In surface soil, average total metal concentrations ($mgkg^{-1}$) were Fe: 1063.8 ± 261, Mn: 30.29

± 19.25, Cu: 24.15 ± 21.69, Pb: 15.08 ± 11.95 and Zn: 8.54 ± 3.18. The factor analysis revealed that Pb, Cu, and Zn were likely of anthropogenic origin, while Mn and Fe were mainly natural. Pb showed the highest mobility. Soil pollution indices indicated slight lead and zinc contamination and moderate copper contamination in the surface soil. The study submitted that cement dust deposition can impact soil heavy metal content, potentially affecting plants and human health.

Contribution to Environmental Effects on Plants

This is a new dimension to our study in the quest for the "The Sojourn of a Physical Environmental Chemist Exploring Environmental Impacts in the Life of Man", Vice-Chancellor sir, we looked into the chemistry of different plants and studied their environmental impact. Plants have stressors which can either be biotic or abiotic. Those chemicals secreted or produced by plants as a means of combating the stress imposed on them by the environment turn out to be a savior to man. These chemicals are referred to as phytochemicals which are found to be therapeutic in nature. So many of them like; tanins, saponis, terpenes, etc turn out to be cure for man's diseases. Mr. Vice-Chancellor, we assessed the environmental factors on secondary metabolites and toxicological effects of *Datura Metel* leaves extracts and found that the extracts of fresh *D. metel* leaves harvested at different times of the day (morning, afternoon, and evening) in different medium (solvents) contains different bioactive compounds. Using Gas Chromatography-Mass Spectrometry (GC-MS) analysis revealed various bioactive compounds present in the extracts. Phytol and 9, 12, 15-octadecatrienoic acid were consistently detected across all harvest times. Toxicological study with Wistar rats gave significant differences ($p < 0.05$) in liver and serum enzyme activities, (AST, ALT, ALP), albumin, protein concentrations, and urea levels. The toxicological effects indicated that the leaf extracts collected at different times of the day may not be entirely safe for consumption at the indicated dosage, as tissue membrane integrity in the rats was not fully preserved. This study highlighted the influence of environmental factors, harvest time, and solvent choice on the bioactive compounds and toxicological effects of *D. metel* leaves (**Abdul Raheem *et al*., 2018a**).

In a similar study with another plant, *Petiveria alliacea*, **Abdul Raheem *et al*. (2018b)** prepared leaf extracts using both non-polar (n-hexane) and polar (ethanol) solvents. In actual fact, there was no significant variation observed in the physicochemical properties of the extracts collected at different times of the day. However, the phytochemical composition differs. The leaves contained flavonoids, terpenoids, alkaloids, saponins, steroids, glycosides and tannins. The composition varied based on the time of sample collection. These compounds play a role in the plant's biological activity and potential pharmacological applications. Results from GC-MS analysis showed major constituents identified in the n-hexane extracts were 9,12,15-octadecatrienoic acid, 3,7,11,15-Tetramethyl-2-hexadecen-1-ol, Squalene, n-Hexadecanoic acid. Major constituents in the ethanol extract were n-Hexadecanoic acid, Phytol, 3, 7, 11, 15-Tetramethyl-2-hexadecen-1-ol, 9, 12-Octadecadienoyl chloride. Environmental effects showed that the variation in constituents could be attributed to sunlight exposure, as other conditions remained constant. Different toxicological effects were also observed when administering leaf extracts to Wistar rats. In summary, *Petiveria alliacea* leaves are rich in bioactive components, and their chemical composition varies with collection time. These findings contribute to our understanding of this remarkable plant's properties.

Vice-Chancellor sir, we are still working on other plants like mistletoe ("Afomo"); stone breaker ("eyinolobe"); violet plant ("ipeta"), and others, with critical interest in the environmental effects, looking into the constituents ground and excited state electrons, detecting their stability for excellent efficiency using both experimental (Chemical, biochemical, histophatological etc) and theoretical knowledge of docking and DFT to achieve quantification of these indigenous folklores.

Soon, our results and patents shall be out to solve health problems locally and internationally as "The Sojourn of a Physical Environmental Chemist Exploring Environmental Impact in the Life of Man" continues.

Community Services

International

Mr. Vice-Chancellor,

1. I was part of the International Scientists who mimicked the atmosphere in the study of Oxidation of a novel Biogenic Volatile Organic Compound: Chamber Studies of the Atmospheric Chemistry of Methyl Chavicol between 2012 and 2013 at University of Birmingham, United Kingdom.
2. In 2008 at the Cape coast, South Africa, I was chosen as a West Africa Representative (Africanness) on Science Plan which elapsed in 2011.
3. I serve as a reviewer to many journal outlets that are Scopus-indexed, notable among them are the Science of the Total Environment (STOTEN), and PLOS one.

National

Vice-Chancellor sir,

1. I was part of the Nigerian Scientists that prepared the National Communication for the country under the Climate Change Convention as the team leader for waste sector between 2009 and 2010.
2. I was part of the Scientists on OKLNG baseline data project, Eti-Osa, Lagos – Ogun States (Riverrine) boundaries on Air Monitoring and Sampling in 2005.
3. I was called upon in 2011 through Chemical Society of Nigeria to serve as an INEC Observer, APBN, in Nigeria Election.
4. I was privileged to be secretary to NIREC-committee on GMO and other alleged socio-economic threats to Nigeria in 2016.
5. I just completed a 3-year tenure as the 15th National Treasurer of Chemical Society of Nigeria in November, 2023.
6. I also served as Financial Secretary of the Political Awareness Group (PAG), Oyo State.

7. Currently I am part of the team on Glocalisation (Learning to Problem-Solve the African Way) of knowledge in Nigeria as we have started from University of Ilorin and the surroundings.
8. I am on board of Al-Ummah Zakat and Sadaqoh Foundation, proposed Al-Ummah University and a member of Project Implementation Committee (PIC) of the proposed Abdulrasaq Abubakar Toyin (AAT) University.
9. I currently work as an adhoc staff for Joint Admission and Matriculation Board.
10. I am serving currently as the Acting President, Alburhan Multipurpose Cooperative Society and
11. President, Almumin Wal Muminat Cooperative Society.

Local (University Community)

I have served the University at various levels through the Department as:

a. Level Adviser that graduated the 2007 set of both Chemistry and Industrial Chemistry programmes.
b. Seminar Coordinator and Postgraduate Coordinator that graduated the highest number of Ph.D. students.
c. Currently the Head of Department, Chemistry.
d. Faculty (member and head of different committees, Representative to other faculties, BCOS and Senate).
e. University (members and head of different committees, currently serving on Hosting Committee for D-8 Network of Pioneering and Research Innovation (NPRI).
f. Former Deputy Director, Unilorin Renewable Energy Centre (UREC).
g. Former Vice- Chairperson, UWABS.
h. Immediate past Chairman, Unilorin Guest Houses Management Board, UGHMB
i. Immediate past Senate Representative on Unilorin Press Management Board and
j. Current, GNS 311 Coordinator.

Conclusion

Vice-Chancellor sir, distinguished audience, my contributions to knowledge in Chemistry confirmed that without atoms (electrons) there wouldn't be evolution of man let alone of his environment and industrialisation. However, handy work of man in the use of his environment constitutes threats to his very existence due to pollution of soil, water and air. For "God is good, all the time"! He made grown the green plants that can clean the environment of man and become a source of healing to his health challenges. "The Sojourn of a Physical Environmental Chemist Exploring Environmental Impact in the Life of Man" confirms the saying: "What on earth is not Chemistry?" a puzzle for all!

Recommendations

Vice-Chancellor sir, based on my research activities, I will like to make the following recommendations:

1. Knowing that "Environmental agencies" are commissions or organisations established for the oversight, administration and protection of the environment and its resources against misuse and degradation from human activity, while the state Environmental Protection Agency (EPA) must remain. I call on the Federal Government of Nigeria to resuscitate the defunct Federal EPA because baseline for primary and secondary pollutants is a national data that cannot be limited to States.
2. Government should provide adequate funding and state of the art equipment necessary for a ground breaking research in physical environmental chemistry to all higher institutions to facilitate infrastructure upgrade, regular monitoring, and pollution control measures.
3. Air is transboundary, so any mishandling of gaseous effluents by industries can become a national/ international problem, I call on Government at all levels to make their EPA to be functional and effective to aid collaboration between government agencies, local communities and environmental agencies for more innovative and sustainable solutions to soil, water and air pollution.
4. Government at all levels should institutionalise a punishment and rewarding system to assist the internal mechanism control for cleanliness of man's environment, promotion of transparent and honesty in all facet of the government parastatals including the higher education sector to achieve a rewarding, peaceful, clean and buoyant economy.
5. Government should note that it is crucial to implement environmental management policies to mitigate the risks posed by heavy metal contamination in soil near dumpsites, water and air for maintaining soil, water, ambient air quality and safeguarding public health.

6. Government should establish state-of-the-art research centers in physical environmental sciences across geopolitical zones with robust funding and comprehensive scientist training. Leadership by federal government, public agencies, or private organizations committed to advancing environmental science is crucial.
7. Industries and Chemistry Departments in Higher Institutions should collaborate to develop biodegradable plastics from renewable sources to address plastic waste and protect marine ecosystems, implement comprehensive pollution control with accessible waste bins and strict regulations. This will enhance University reputation and spur economic growth.
8. Chemistry Department in Higher Institutions should partner with international organisations like the United Nations to enhance their environmental chemistry research.
9. Chemistry Department in Higher Institutions can use biomimetic technologies and nano catalysis to tackle global challenges in water and air purification, accelerating conservation efforts for a healthier planet.
10. Physical Environmental Chemists should unite with biologists, biochemists, engineers, medical personnel and social scientists in Interdisciplinary research to tackle complex environmental challenges. These collaborative efforts will advance biomimetic technologies and sustainable energy initiatives, harnessing diverse expertise for effective solutions.
11. Local Government heads should prioritize community engagement for environmental sustainability and social inclusivity. They should partner with Chemistry Department within their locale to empower local communities with sustainable practices through collaborative research and environmental chemistry expertise, and
12. Government and Higher Institution Managements should create a clean, hygienic environment with zero tolerance for open defecation to promote public health.

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Vice –Chancellor sir, kindly permit me to end with this little but highly loaded song:

"Emi Sope fun Olohun Oba (2x),
Oba tio doju Adu'a timi,
Oba tio ja seti o woro mioooooooooo, emi sope fun Olohun Oba" 2x

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