UNIVERSITY OF PORT HARCOURT

MY FUNCTIONAL GROUP AFFAIRS: PATHWAY TO …….?

An Inaugural Lecture

By

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DEDICATION

This inaugural lecture is dedicated firstly to GOD almighty and secondly to my bundle of joys Ethan, Aliyah, Elora, Aliza and Eliana whom I love dearly.

ACKNOWLEDGEMENTS

Mr. Vice-Chancellor, permit me a few minutes to acknowledge some persons who played key roles in shaping my life and future.

I thank Lord God Almighty most sincerely for lifting me up, planting my feet on higher grounds, and granting me the Grace by making this day possible. May He alone be praised and glorified.

I am grateful to my late parents Mr Upadibe Ideozu ("the Boy is Good") and Mother Mrs Rhoda Ideozu (nee Esukpa) whose love, care and proper upbringing initiated my future; may their gentle souls rest in peace. I would not fail to mention my siblings Fortune, Anthony and Bertha with their families; their love and prayers are appreciated. My late brothers families are not forgotten; may they all have peace.

I would like to express my special gratitude to my husband and my life partner Arc. Nnamdi Obuzor who encouraged me, supported all my quest and made sure that I became educated. His "elastic" tolerance and support to all my academic and professional travels are profoundly appreciated. I am very much grateful to my children Earl, Raymond, Sharon, Marshal, Chinwe, Edmund, Lauretta, and Donald who have always believed and stood by me. Thanks.

I acknowledge the contributions of some great academics at various points of my academic life notably amongst who are: Dr. G. Eng, Prof. A. C. I. Anusiem, Dr. B. L. Booth, Prof. A. I. Spiff, Prof. A. A. Abia, Prof. M. Horsfall *Jnr*., Prof. E. O. Anosike, Prof. B. W. Abbey, Prof. J. A. Ajienka, Prof. E. Nduka, Prof. B. E. Okoli, and Prof. S. N. Okiwelu.

I appreciate the members of the Chemical Society of Nigeria for all their contribution to my growth. Members of the Department of Pure and Industrial Chemistry have been so supportive to me and I am grateful.

Finally I would like to thank the Vice Chancellor of the University of Port Harcourt (Prof. N. S. E. Lale) and the University Administration for making it possible for me to deliver the 143rd Inaugural lecture of today and you the audience I also thank you for your presence and attention.

ORDER OF PROCEEDING

2.45P.M. GUESTS ARE SEATED

3.00P.M. ACADEMIC PROCESSION BEGINS

The procession shall enter the Ebitimi Banigo Auditorium, University Park, and the Congregation shall stand as the procession enters the hall in the following order:

ACADEMIC OFFICER
PROFESSORS
DEANS OF FACULTIES/SCHOOL
DEAN, SCHOOL OF GRADUATE STUDIES
PROVOST, COLLEGE OF HEALTH SCIENCES
ORATOR
LECTURER
REGISTRAR
DEPUTY VICE-CHANCELLOR [ACADEMIC]
DEPUTY VICE-CHANCELLOR [ADMINISTRATION]
VICE CHANCELLOR

After the Vice-Chancellor has ascended the dais, the congregation shall remain standing for the University of Port Harcourt Anthem.
The congregation shall thereafter resume their seats.

THE VICE CHANCELLOR‘S OPENING REMARKS.

The registrar shall rise, cap and invite the Vice-Chancellor to make the opening Remarks.

THE VICE CHANCELLOR SHALL THEN RISE, CAP AND MAKE HIS OPENING REMARKS AND RESUME HIS SEAT.

THE INAUGURAL LECTURE

The Registrar shall rise, cap and invite the Orator, Prof. Victory Uche Dienye to introduce the Lecturer.

The Orator shall then rise, cap and introduce the Lecturer, and resume her seat.

The Lecturer shall remain standing during the Introduction. The Lecturer shall step on the rostrum, cap and deliver her Inaugural Lecture. After the lectures, he shall step towards the Vice-Chancellor, cap and deliver a copy of the Inaugural Lecture to the Vice-Chancellor and resume her seat. The Vice-Chancellor shall present the document to the registrar.

CLOSING
The Registrar shall rise, cap and invite the Vice-Chancellor to make his Closing Remarks.

THE VICE-CHANCELLOR’S CLOSING REMARKS.
The Vice-Chancellor shall then rise, cap and make his Closing Remarks. The Congregation shall rise for the University of Port Harcourt Anthem and remain standing as the Academic [Honour] Procession retreats in the following order:

VICE CHANCELLOR
DEPUTY VICE-CHANCELLOR [ADMINISTRATION]
DEPUTY VICE-CHANCELLOR [ACADEMIC]
REGISTRAR
LECTURER
ORATOR
PROVOST, COLLEGE OF HEALTH SCIENCES
DEAN, SCHOOL OF GRADUATE STUDIES
DEANS OF FACULTIES/SCHOOL
PROFESSORS
ACADEMIC OFFICER

PROTOCOL

Vice Chancellor Sir,

Deputy Vice-Chancellors,

Registrar and other Principal Officers,

Provost College of Health Sciences,

Deans of Faculties,

Distinguished Professors and Scholars,

Great Students of Unique Uniport,

Distinguished Guests,

Ladies and Gentlemen.

With great pleasure, I welcome you all to this inaugural lecture.

INTRODUCTION

1.1 Preamble

Mr. Vice-Chancellor Sir, it is with a deep sense of humility that I present the 143rd Inaugural Lecture of the University of Port Harcourt and I appreciate you most sincerely for the opportunity given to me to do so but I give thanks to God who “upholds me with his victorious right hand”. An inaugural lecture provides an excellent opportunity for new Professors to share their achievements in research, innovation, engagement and teaching activities (past, present and future) before an audience of members of the University community and the general public. Inaugural Lecture is delivered by newly established professors within the University and aims to give an illuminating account of the speaker's own subject specialism. However, may I also include that it’s also a splendid avenue of self-advertisement of a new professor to town and gown. I have been a Professor for some 5 years now; but I can’t rightly say whether I’m a new or an old Professor but I thank you once more for affording me the opportunity of mounting this academic podium at this quint moment.

1.2 Basic Concepts

Mr. Chairman Sir, this inaugural lecture is embedded in chemistry and I shall try to carry everybody along particularly members of the audience whose background in chemistry is on the marginal yet deem it fit to honour this special august invitation.

Chemistry is the study of matter and its properties, the changes that matter undergoes and the energy associated with these changes. Matter on the other hand is anything that has mass and volume. Chemistry is the central science. It rests on the foundation of mathematics and physics and in turn underlies the life sciences in biology and medicine. In order to understand the living system fully, one must first understand the chemical reactions and chemical influences that operate within them. It is a core subject in all science related programmes: agriculture, engineering, medicine, biochemistry, microbiology, pharmacy etc. Chemistry is a broad subject, which is subdivided into four major branches namely: organic, inorganic, analytical and physical chemistry but with several specialty areas within the four major branches. Some of these specialty areas are a combination of some aspects of the major branches.

Organic Chemistry: This is the study of chemistry of carbon and its compounds. This branch of chemistry deals with synthesis, characterization and application of compounds that have been classified as hydrocarbons and hydrocarbon derivatives.

Inorganic Chemistry is the study of substances that do not contain carbon bonded to hydrogen. It studies the chemistry of metals (iron, nickel, copper etc), non-metals (oxygen, sulphur, nitrogen, etc), and metalloids which are elements that possess both metallic and non-metallic properties (silicon, germanium etc), which is the backbone of the silicon and electronic industry.

Analytical Chemistry: This is the branch of Chemistry that applies physical and chemical concepts in the detection and estimation of the amount of a substance in a sample. This branch of Chemistry is also involved in the development of the detection and estimation techniques.

Physical chemistry applies the mathematical theories and methods of physics to the properties of matter and to the study of chemical processes and the accompanying energy changes.

Chemistry as science is challenging but an exciting subject as an academic discipline with unique designated universal language. Its principles and ideas are to develop processes, technics and produce the chemicals from which all manner of materials and consumer products are manufactured.

Who is a Chemist?

Often the word Chemist to a number of people means the person who dispenses drugs in a pharmacist's store. No! A chemist is a person who has **UNDERGONE** training in chemistry as a discipline and practices chemistry as a profession either as a teacher or **PRACTICES** in any applied aspect of chemistry like chemical manufacturing or allied industries.

In general, chemistry professionals **STUDY** the composition, structure and characteristics of matter in an attempt to improve existing substances and products, discover new ones, improve and develop chemical processes in line with technological advancement.

Listen to what one author wrote about chemists:
"In the beginning God made heaven and earth. And God saw everything that He made, and behold it was very good…and on the seventh day, He rested (Gen 1:1 and 2:2). After God rested there were other things that still needed to be made due to the insatiable demands of human beings, therefore God looked upon the face of the earth and found His chosen friends (the Chemists) and He commissioned them to continue with the creation, transformation and refining other things which still needed to be created from those things that had been made. Chemists are therefore, the chosen friends of God.

It was late Dr. A. K. Fasina of blessed memory, a renowned chemist and the fifth President of the Chemical Society of Nigeria (CSN) of which I am the thirteenth who said, *"The greatest power in the world* *is the power of creating something from nothing; that power belongs to God. The next power is that of changing matter from one form to another; God gave that power to chemists."*

"What better profession should anyone wish to be called into other than chemistry?"

1.3 IMPACT OF CHEMISTRY ON SOCIETY

This power conferred on the chemist can be appreciate due to the impact of chemical industry on modern society as we take a quick look around us even as we are seated now Smiley and Jackson, 2002. "For example, when you get up in the morning, you brush your teeth using toothpaste, which is a mixture of chemicals squeezed from a plastic tube onto plastic bristles mounted in a plastic handle. You may take a shower using soap and shampoo, each made by the chemical industry, and finally dry, brush, or comb you hair with other articles made of plastic. While doing this, you will likely be looking into a mirror over porcelain or refined marble sink (sand and chemical mixtures) while standing on vinyl plastic floor covering, tile, or carpeting, all of which are products of the chemical industry. The varnish coating, the wooden floors of your house and the paint of wallpaper covering the walls are products of the chemical industry. At breakfast, it is likely that the kitchen counters and table are topped with plastic, as are the chairs. The refrigerator would not work without chemicals either for the refrigerator unit or the insulation in its walls. The interior is plastic lined and the exterior has a durable coating made possible by the chemical industry. Your breakfast food is probably fresh because it was treated with chemical preservatives and/or shipped in a box with a plastic lining. The car or bus that you go to work in is totally chemical dependent, from the anti-corrosion treatment of the metal, the protective paint and the plastic parts and tires to the chemical battery that starts the vehicle, the oil that lubricates it, and the gasoline that fuels it. The vitamins and supplements that you took today, your perfume, the wine you drank at dinner, your cell phone, this microphone; and so it goes on and on". Indeed, life as we know it today could not exist without chemistry and the chemical industry. No wonder the self-important maxim of Chemists: **"WHAT ON EARTH IS NOT CHEMISTRY?"** In other words, **CHEMISTRY RULES THE WORLD!** As chemistry rules the world, chemists are charged to practice and abide by the **Global Chemists' Code of Ethics**, which has five components that refers to Environment, Research, Scientific Writing and Publishing, Safety and Security.

1.4 "GLOBAL CHEMISTS' CODE OF ETHICS

Introduction - Making Positive Change Happen

Chemical practitioners[1] should promote a positive perception and public understanding and appreciation of chemistry. This is done through research, innovation, teamwork, collaboration, community outreach, and high ethical standards. Chemistry professionals[2] should act as role models, mentors, and advocates of the safe and secure application of chemistry to benefit humankind and preserve the environment for future generations. They should instill and encourage curiosity and innovation early and often, and recognize and award achievements where appropriate. Finally, chemistry professionals should provide professional inputs and opinions to government and other decision makers regarding industrial, environmental, and other issues.

Environment

Environmental sustainability should be an integral part of research and education. Chemistry Professionals must use their expertise to ensure the safety and health of coworkers and the community, and to protect the environment for future generations. Chemical practitioners should work within their organizations to help develop sound environmental plans and policies. Chemistry professionals should encourage inclusion of environmental sustainability as a key element in chemistry instruction and engagement with the community. Chemical practitioners are responsible to ensure the proper use and disposal of chemicals and instruments. They should endeavor to increase their knowledge of the short and long term effects of chemicals on the environment and to apply informed quality control principles.

Research

Research in chemical sciences should benefit humankind and improve quality of life, while protecting the environment and preserving it for future generations. Researchers should conduct their work with the highest integrity and transparency, avoid conflicts of interest, and practice collegiality in the best way. Research should promote the exchange of new scientific and technological information and knowledge relating to the application of chemistry for the benefit of humankind and the environment.

Scientific Writing and Publishing

Scientific publication is a way to share new knowledge. Chemistry professionals should promote and disseminate scientific knowledge in research and innovation through outreach, scientific writing and publication for sustainable development. Chemistry professionals should maintain honesty and integrity in all stages of the publication process, which must meet the highest possible standards of data reproducibility and correctness without plagiarism. Chemistry professionals who supervise others have a responsibility to ensure that their scientific writings are free of defects and errors. Chemistry professionals should promote peaceful, beneficial applications and uses of science and technology through a variety of media. Chemistry professionals have a responsibility to assess information intended for release prior to dissemination.

Safety

A culture of safety is very important and should be sustained by management, including academic, industrial and government leadership. Management should work with chemical practitioners in all aspects of safety including training, regular audits and the development of safety culture. There should always be awareness of safety regulations protecting health and the environment. All chemical practitioners should exercise safety procedures. Engineering and administrative controls for safety should be in place. Proper personal protective equipment and garments should be used when working with chemicals or in an area with hazards.

Security

A culture of security is important to protect dual use chemicals and facilities. All stakeholders in the chemical supply chain should ensure and practice chemical security. Chemical practitioners should ensure that laboratories and industrial facilities have the capacity to secure chemicals. Security measures need to be reviewed regularly. Management should have oversight of security and should follow all local and international laws and regulations.

1. **Chemical practitioners:** Scientists, engineers, technicians, trades people, business people or anyone else who has contact with chemicals at work or at home.

2. **Chemistry professionals:** As a subset of chemical practitioners, chemistry professionals refers to scientists and engineers, who, by virtue of their specialized education, certifications or licensures, are authorized to offer chemistry services to the public.

In April 2016, American Chemical Society International Activities gathered 30 scientists from 18 countries (I represented Nigeria and the Chemical Society of Nigeria) for a workshop in Kuala Lumpur, Malaysia to collaboratively draft an actionable Global Chemists' stakeholders Code of Ethics (GCCE), guided by The Hague Ethical Guidelines and the Code of Conduct Toolkit.

The word chemistry has been found to be a suitable term used in many areas of life ranging from science, humanities to arts because Chemistry is the science of the events of changes resulting from the process of interaction. Hence a good interaction is regarded as good chemistry giving us chemistry in politics to explain the mechanism that leads to changes that occur when good policies are implemented or bad chemistry when awful policies are imposed on the people. Socially, it is the chemistry of the interaction between two individuals that are in love that culminates to a unique affair.

2.1. SYNTHESIS

Chemical synthesis is the purposeful execution of one or more named reactions to obtain a product, or several products Vogel *et al.*, 1996. This is the construction of complex chemical compounds from simpler ones; in modern laboratory usage, this tends to imply that the process is reproducible, reliable, and established to work in multiple laboratories. It is the process by which many substances important to daily life are obtained. It is applied to all types of chemical compounds, but most syntheses are of organic molecules. Chemists synthesize chemical compounds that occur in nature in order to gain a better understanding of their structures. Synthesis also enables chemists to produce compounds that do not form naturally for research purposes. Industrially, synthesis is used to make products in large quantity.

Chemical compounds are made up of atoms of different elements, joined together by chemical bonds. Chemical synthesis usually involves the breaking of existing bonds and the formation of new ones. Synthesis of a complex molecule may involve a considerable number of individual reactions leading in sequence from available starting materials to the desired end product. Each step usually involves reaction at only one chemical bond or functional group (site of reactivity) in the molecule.

In planning the route of chemical synthesis, chemists usually visualize the end product and work backward toward increasingly simpler compounds. For many compounds, it is possible to establish alternative synthetic routes. The ones actually used depend on many factors, such as cost and availability of starting materials, the amount of energy needed to make the reaction proceed at a satisfactory rate, and the cost of separating and purifying the end products. Moreover, knowledge of the reaction mechanism and the function of the chemical structure (or behaviour of the functional groups) help to accurately determine the most-favoured pathway that leads to the desired reaction product https://www.britannica.com/science/reaction-mechanism.

A goal in planning a chemical synthesis is to find reactions that will affect only one part of the molecule, leaving other parts unchanged. Another goal is to produce high yields of the desired product in as short a time as possible. Often, reactions in a synthesis compete, reducing the yield of a desired product. Competition can also lead to the formation of side products which can be difficult to separate from the main one. In some industrial syntheses, by-product formation can be welcome if the by-products are commercially useful. Diethyl ether, for example, is a by-product of the large-scale synthesis of ethanol (ethyl alcohol) from ethylene. Both the alcohol and ether are valuable and can be separated easily.

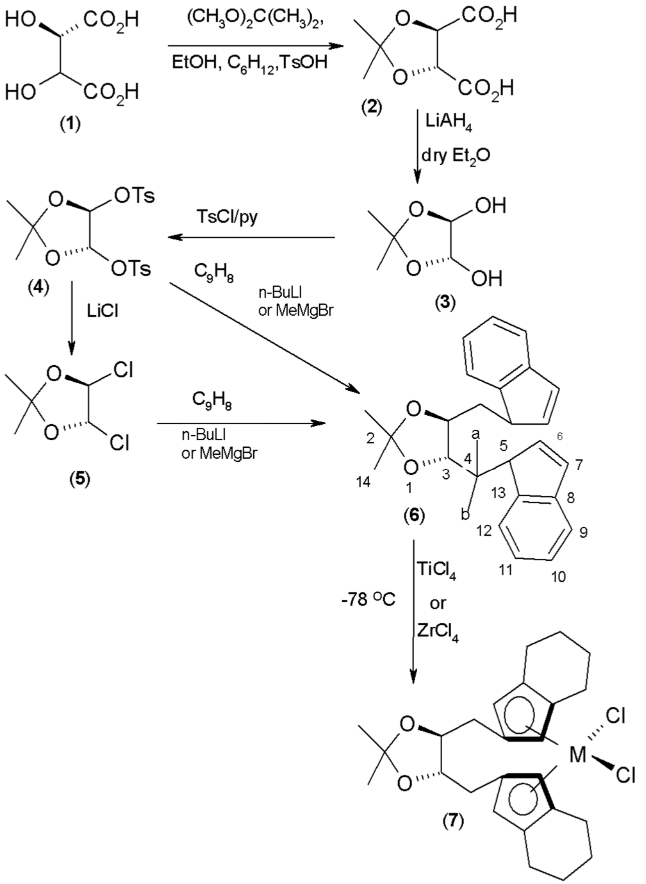
"**My Functional Group Affairs**" as the title reads is unique; in that it's a reminder that groups really do have interaction "an affair"; be it politically (politicians), socially (friends and family) or chemically (functional groups). The major difference is the resultant outcome.

In organic chemistry, functional groups are specific groups (moieties) of atoms or bonds within molecules that are responsible for the characteristic chemical reactions of those molecules; regardless of the other atoms present in a molecule. The same functional group will undergo the same or similar chemical reaction(s) regardless of the size of the molecule it is a part of March, 1985. However, its relative reactivity can be modified by other functional groups nearby. The atoms of functional groups are linked to each other and to the rest of the molecule by covalent bonds.

TABLE 1. SOME COMMON FUNCTIONAL GROUPS

S/N	Functional groups	Examples
	C-H	Alkane, alkene, alkyne and benzene derivatives (hydrocarbyl)
	C-X	Chlorine, fluorine, iodine, and bromine (halogens)
	C-O	Alcohol, ketone, aldehyde, acetyl aldehyde, carbonate, carboxylate, carboxylic acid, ester, methoxy, hydroperoxide, peroxide, ether etc
	C-N	Amides, amine, imine, azide, imide, nitric, nitrate etc
	C-S	Thiol, thioether, sulfoxide, sulfone, sulfonic acid etc
	C-P	Phosphine, phosphate, phosphonic acid etc.
	C-B	boronic acid, boronic ester, borinic acid and borinic

My functional group affairs initially occurred with five groups [carboxylic (COOH), halogen (-X), alcohol (-OH), tosylate (Ts) and diene (=)] using Scheme 1 below.

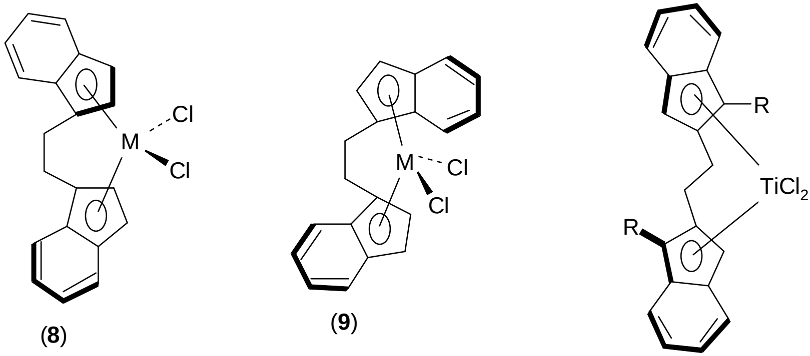


Scheme 1: Preparation of (4S,5S)-trans-4,5-(bisindenylmethyl)-2,2-dimethyl-1,3-dioxolanetitanium dichloride (**7a**) and -zirconium (**7b**) (M = Ti or Zr)

2.2. Protection of the diol (2,3-dihydroxybutanedioic acid) (**1**) using 2,2-dimethoxypropane gave (**2**) a diester in 94% yield (lit.92%) Mash *et al.,* 1986. The reduction of the diester (**2**) using lithium aluminium hydride gave diol (**3**) as pale yellow oil in 82% yield (lit. 66%) Mash *et al.,* 1986. The conversion of the diol (**3**) to the ditosylate was achieved by treating the diol with *p*-toluenesulfonyl chloride in pyridine, Rubin and Fisher 1952. After workup and recrystallization, the ditosylate was obtained in pure form as a white solid in 91% yield (lit. 95% Rubin and Fisher 1952) with a melting point of 92-93.5 °C (lit.92-93 °C Rubin and Fisher 1952). The ditosylate (**4**) was changed to 4,5-di (chloromethyl)-2,2-dimethyl-1,3-dioxolane (**5**) as Townsend *et al.*,1980, had reported that this gave higher yields and cleaner products than the ditosylate (**4**) in their preparation of a diphospine. The target product (4S,5S)-*trans*-4,5-bis(1H-indene-3-ylmethyl)-2,2-dimethyl-1,3-dioxolane (**6**) was synthesized by reacting three equivalents of lithium indenide with either one equivalent of 4,5-bis(toluene-*p*-sulphonyloxomethyl)-2,2-dimethyl-1,3-dioxolane (**4**) or one equivalent of 4,5-di (chloromethyl)-2,2-dimethyl-1,3-dioxolane (**5**) in THF at 0 °C, stirred at room temp. for 30 minutes and then refluxed for 1 hr. After workup and purification by chromatography (silica gel 60H hexane/diethyl ether 3:1), the product was obtained as green oil in 75% yield using (**4**) and in 78% yield using (**5**). Metallation of complex (**6**) with Titanium tetrachloride (IV) or Zirconium tetrachloride (IV) yielded the metellocenes (**7a and 7b**) in appreciable yield. Compounds **1-7** were fully characterized using Micro analysis, Mass Spec., IR, ^{1}H NMR, and ^{13}C NMR.

2.3 Spectral data of (4S,5S)-trans-4,5-(bisindenylmethyl)-2,2-dimethyl-1,3-dioxolanetitanium **(6).** The ^{I}H NMR (300 MHz, $CDCI_3$). δ: 1.4. (ddd. 2H.J (H_{4a}-H_{4b}) 13.6Hz, J (H_{4b}-H_3) 9.2Hz, J (H_{4b}-H_5) 10.8Hz,H_{4b}), 1.6 (s, 6H, H_{14}), 2.5 (ddd. 2H, J (H_{4a}-H_{4b})13.6Hz, J (H_{4a}-H_3) 9.2Hz, J(H_{4a}-H_5)10.8Hz, H_{4a}), 3.8 (m, 2H, H5), 4.05 (d, 2H, J 9Hz, H_3) 6.5 [d, 2H, J 7.5Hz, olefinic]; 6.8 [d, 2H, J 7.5Hz, olefinic]: 7.1-7.5 (complex, 8H, aromatic). ^{13}C NMR δ (70 MHz, $CDCI_3$) δ 27.1 (C_{14}), 39.0 (C_4), 44.3 (C_5), 78.5 (C_3), 110.5 (C_2), 123.7 (C_{12}), 124.6 (C_9), 124.6 (C_{10}), 126.2 (C_{11}), 132.0 (C_6), 134.1 (C_7), 143.6 (C_{13}), 144.8 (C_8). [Found: C,83.4; H,7.2: $\underline{M}$ 358 $C_{25}H_{26}O_2$ requires C,83.7; H, 7.3. MS (FAB) m/z 359 (M+1) 76%]. Reaction of complex (**6**) with $TiCl_4$ afforded (4S,5S)-trans-4,5-(bisindenylmethyl)-2,2-dimethyl-1,3-dioxolanetitanium dichloride

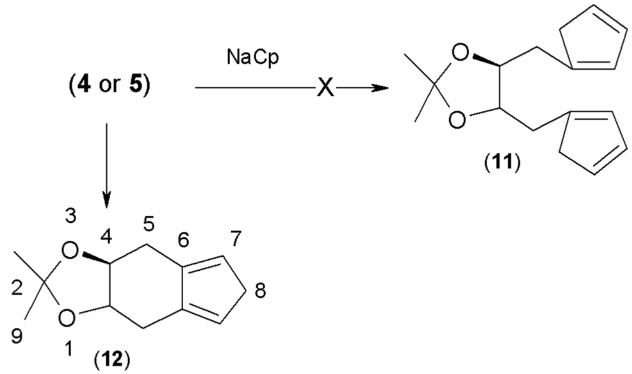
(7a) oil**:** MS (FAB) m/z 478 (M+1) 66%], no fragmentation. Reaction of complex (**6**) with $ZrCl_4$ afforded an oil containing (4S,5S)-trans-4,5-(bisindenylmethyl)-2,2-dimethyl-1,3-dioxolanezirconium dichloride **(7b):** MS (FAB) m/z 521 (M+1) 82%], no fragmentation.



(**8**) (**9**) (**10**)

Fig. 1: M = Ti, Zr or Hf; R = CH_3 or CH_2Ph

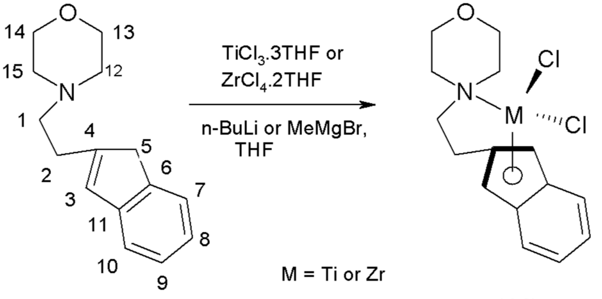
Metallocenes (**7a and 7b**) scheme 1 Obuzor and Booth 2010 were similar to metallocenes (**8-10**) Figure 1, Wild *et al.,* 1982; Ewen*et al.,* 1987 and Grossman *et al.,* 1991. These metallocenes have been used effectively as catalysts for polymerization of ethylene and propylene together with methylaluminoxane (MAO) as co-catalysts and we hoped that our metallocenes would be subsequently used as metallocenes (**8-10**). These and other innovations have inspired development of new classes of catalysts that in turn led to commercialization of novel engineering polyolefins. A **metallocene** is a compound typically consisting of two cyclopentadieneyl anions (Cp, which is C_5H_5) bound to a metal centre (M) in the oxidation state II, with the resulting general formula $(C_5H_5)_2$ M. Metallocenes are a subset of a broader class of organometallic compounds called sandwich compounds. The cyclopentadienyl anions with circles inside them indicate that they are aromatically stabilized. An ***ansa*-metallocene** is a type of organometallic compound containing two cyclopentadienyl ligands that are linked by a bridging group such that both cyclopentadienyl groups are bound to the same metal. The link prevents rotation of the cyclopentadienyl ligand and often modifies the structure and reactivity of the metal center. Some ansa-metallocenes are active in Ziegler-Natta catalysis.



Scheme 2: Synthesis of (4S,5S)-trans-4,5-(cyclopentadienylmethyl) -2,2-dimethyl-1,3-dioxolane

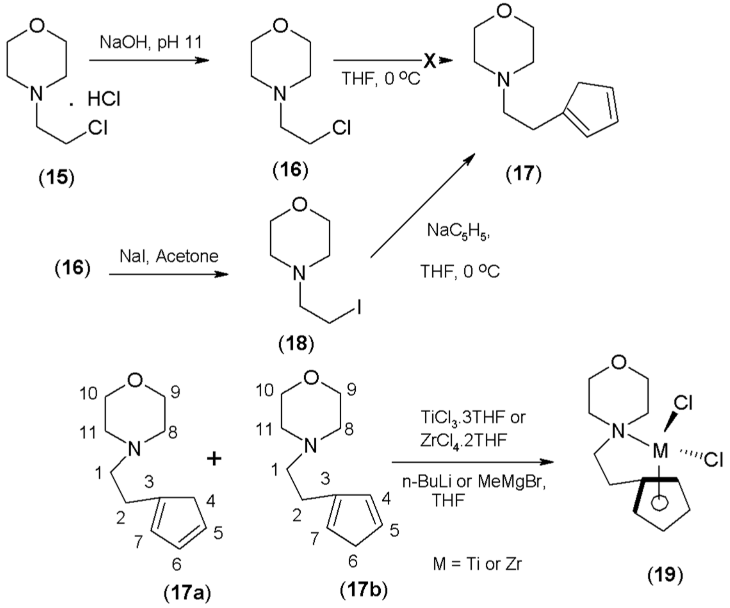
2.4 The synthesis of (4S,5S)-trans-4,5-bis (cyclopentadienylmethyl)-2,2-dimethyl-1,3-dioxolane (**11**) was not feasible due to the isomerization of cyclopentadiene moiety to give us my “JEWEL” compound (**12**) in 23% yield. I earned two pounds from my supervisor each time I produced 1gram of compound (**12**). I was relieved of this production after my first fifty pounds and a post-doctor was engaged.

Synthesis of **(4S,5S)-trans-4,5-(cyclopentadienylmethyl)-2,2-dimethyl-1,3-dioxolane** (**12**): To the ditosylate (**4**) (4.7g, 0.01mol) in THF (50cm^3) in a dry, one-litre three necked flask fitted with an argon inlet and outlet, and a magnetic stirrer, was added sodium cyclopentadienide (1.38g, 0.015mol) in THF (50cm^3) at 0 °C. The reaction mixture turned brown and was stirred at room temperature for 18 h. Aqueous acidic (HCl) workup and subsequent flash chromatography on neutral (20% ether in hexane) yielded yellow oil which was crystalized to give white crystals (0.44g, 23%), m.p. 44-44.5 °C. IR spectrum showed V_{max} (neat) 2923br m (-CH), 2725m, 1461m, 1377m, 1283w (-CH_2), 1233w, 1104m, 1073m, 1023m, 965w, 852w, 791m, 722cm^{-1}, ^{1}H NMR (300MHz, $CDCL_3$) δ 1.48 (s, 6H, H_9), 2.40- 2.48 (m, 2H, H_4), 2.75-2.9 (m, 4H, H_5), 3.79 (m, 2H, H_7), 6.3 (s, 2H, H_8) ppm; ^{13}C NMR (70MHz, $CDCl_3$) 27.1 (C_9), 30.1 (C_8), 43.0(C_5), 78.5 (C_4), 110.4 (C_2), 132.4 (C_7), 133.6 (C_6) ppm. [Found: C,74.9; H,8.1, M 192. Cacld. For $C_{12}H_{16}O_2$: C,75.0: H,8.3 MS(FAB) m/z 192(M+1)]. This was identified as compound (**12**) and these data were in agreement with literature values Halterman and Vollhardt, 1988.



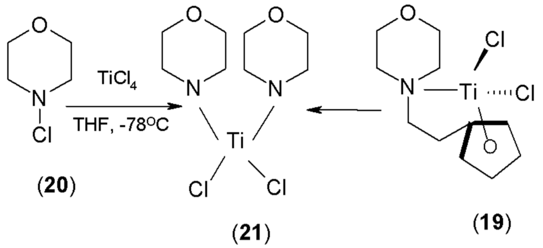
Scheme 3: Synthesis and metallation of 4-(2-indenylethyl)morpholine (**13**)

2.5 The crude oil (10.9g, 95%) of 4-(2-indenylethyl) morpholine (**13**) obtained by the reaction of indenyllithium and 4-(2-chloroethyl) morpholine was fractionally distilled under vacuum (in a sand-bath) to give the product (**13**) (5.4g, 0.023mol, 71%) as light brown oil, b.p. 230-236 °C (1.0mm Hg), ^{I}H NMR (300 MHz, $CDCI_3$) δ 2.75 (br s, 4H, H_1 and H_2), 2.90 (m, 4H, H_{12} and H_{15}), 3.5 (s, 2H, H_5), 3.9 (m, 4H, H_{13} and H_{14}), 6.3 (s, 1H, H_4), 7.2-7.65 (complex, 4H, aromatic) ppm; ^{13}C (70 MHz, $CDCI_3$) δ 24.9 (C_2), 37.6 (C_5), 53.5 (C_{12}), 57.6 (C_I), 66.8 (C_{13}), 118.6 (C_7), 123.6 (C_{10}), 124.5 (C_8), 125.9 (C_9), 128.3 (C_4), 142.0 (C_3), 144.0 (C_6), 145.0 (C_{11}). IR **ν**$_{max}$ (neat) 3070w, 3020w, 2980m, 2860m, 2710m, 1620w, 1460m, 1125m, 1120s, 1005m cm^{-1}. [Found: C, 78.7; H, 8.4; N, 6.2. M 229. Calc for $C_{15}H_{19}ON$ requires C, 78.6; MS (FAB) m/z 230 (M+1) 72%]. Metallation of 4-(2-indenylethyl) morpholine (**13**) with $ZrCl_4$ gave the metellocene 4-(2-indenylethyl) morpholinezirconium dichloride (**14a**) MS (FAB) m/z 331 (M + 1) while metallation with $TiCl_4$ gave 4-(2-indenylethyl) morpholinetitanium dichloride (**14b**) MS (FAB) m/z 278 (M + 1).



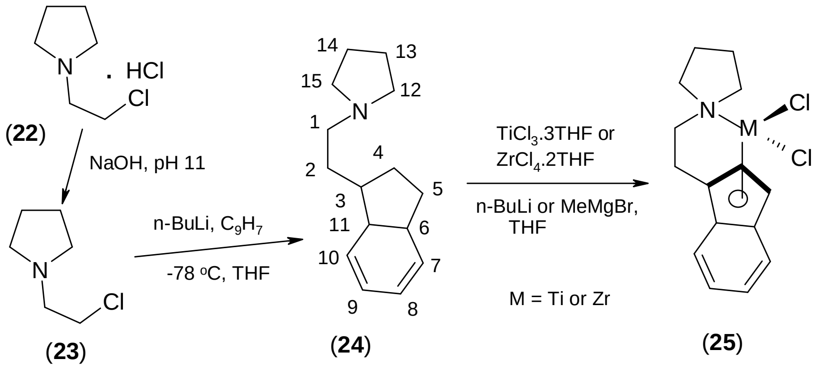
Scheme 4: Synthesis and metallation of 4-(2-cyclopentadienylethyl)morpholine (**17**)

2.6 The reaction of sodium cyclopentadienide with 4-(2-chloroethyl) morpholine (**16**) in THF to obtain (**17**) was very slow even after 18hr of stirring at room temperature less than 10% of the starting material has reacted Townsend *et al.,* 1980. At reflux condition several spots were observed Bandy *et al.,* 1991. In an attempt to improve the rate of substitution, the chloro derivative (**16**) was converted to the iodo analogue (**18**) which is a better leaving group. Treatment of compound (**18**) with sodium cyclopentadienyl at reduced temperature afforded the desired product 4-(2-cyclopentadienylethyl) morpholine (**17**) as a mixture of two isomers (**17a** and **17b**) after fractional distillation under reduced pressured. B.p. (98-104 ^{o}C/1mm Hg), (6.2g, 0.035mol, 82%) yield. ^{I}H (300 MHz, $CDCI_3$) δ 2.4 (s, 4H, H_I and H_2), 2.6 (s, 4H, H_8 and H_{11}), 2.8 (d, 2H, J 3.4Hz, H_{6a} or H_{4b}]), 3.6 (s 4H, H_9 and H_{10}), 5.81-6.3 (complex, 3H, olefinic) ppm. ^{13}C (300MHz, $CDCI_3$) δ 27.7 and 28.0 (C_2), 41.0 and 43.6 (C_{6a} or 4_b), 53.5 (C_8), 57.4 and 58.1 (C_I), 66.6 (C_9), 126.3 and 126.6 (C_{5a} or C_{5b}), 130.5 and 131.7 (C_{4a} or C_{6b}), 133.4 and 134.3 (C_{7a} or C_{7b}), 144.4 and 146.7 (C_{3a} or C_{3b}). IR ν_{max} (neat) 3060w, 2940w, 2740w, 2700w, 1600w, 1450w, 1110m cm^{-I}. [Found: C, 74.1; H, 9.3; N, 8.2 $\underline{M}$ 179, Calcd. for $C_{11}H_{17}NO$ requires C, 74.2; H, 9.0; N, 7.9 MS (FAB) m/z 180(M+1)79%.Metallation of complex (**17**) with $TiCl_3$.3THF gave the 4-(2-cyclopentadienylethyl) morpholinetitanium dichloride (**19a**) MS (FAB) m/z 228 (M + 1) while metallation with $ZrCl_4$.2THF afforded 4-(2-cyclopentadienylethyl) morpholinezirconium dichloride (**19b**) MS (FAB) m/z 271 (M + 1).



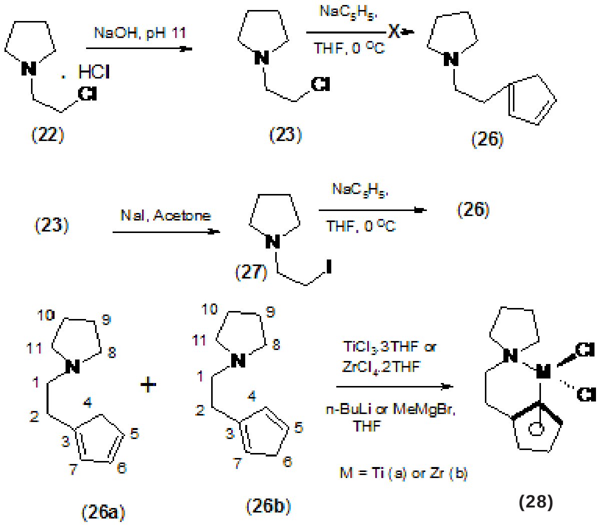
Scheme 5. Precipation and synthesis of dimorpholinetitanium dichloride (**21**)

2.7 During the synthesis of 4-(2-cyclopentadienyethyl) morpholinetitanium dichloride (**19**); di (morpholine) titanium dichloride (**21**) Obuzor and Booth, 2012 precipitated as a by-product in the first ether wash in 9% yield which prompted us to design its formation using morpholine chloride (**20**) as its starting material and (**21**) was the obtained in 74% yield. Metellocene (**21**) was fully characterized using using Micro analysis, Mass Spec., IR, ^{1}H NMR, and ^{13}C NMR.



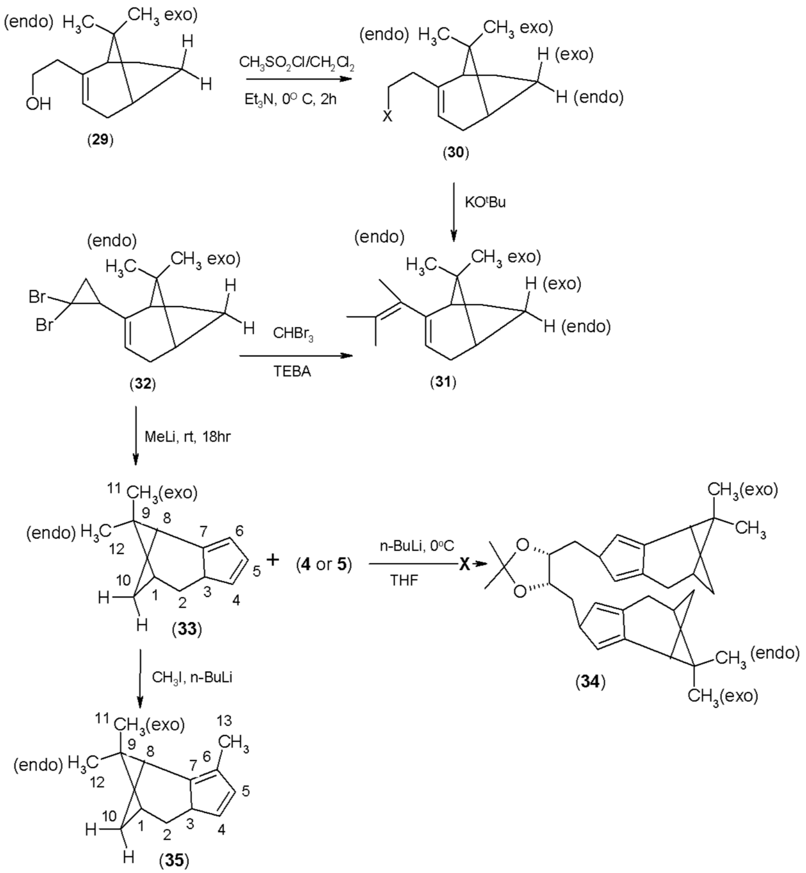
Scheme 6: Synthesis and metallation of 4-(2-indenylethyl)pyrrolidine (**24**)

2.8 Treatment of 4-(2-chloroethyl) pyrrolidine (**23**) with indenyllithium at reduced temperature afforded crude 4-(2-indenylethyl) pyrrolidine (**24**) after work-up. The crude oil (8.1g, 92%) was fractionally distilled under vacuum (in a sand-bath) to give the product (**24**) as light brown oil (6.6g, 0.030mol, 82%) yield; b.p. 219-223 °C (1.0mm). ^{1}H NMR (300MHz, $CDCl_3$) δ 1.7 (s, 4H, H_{13} and H_{14}), 2.5 (s, 4H, H_1 and H_2), 2.63 (s, 4H, H_{12} and H_{15}), 3.2 (s, 2H, H_5), 6.1 (s, 1H, H_4), 7.0-7.4 (m, 4H, aromatic) ppm. ^{13}C NMR (75MHz, $CDCl_3$) δ 23.7 (C_{13} and C1$_4$), 27.8 (C_2), 37.9 (C_5), 54.4 (C_{12} and C_{15}), 55.3 (C_1), 119.0 (C_{10}), 124.2 (C_7), 124.7 (C_9), 124.9 (C_8), 126.4 (C_4), 142.7 (C_3), 144.4 (C_{11}), 145.4 (C_6). IR ν_{max} (neat) 3070w, 3020w, 2960s, 2790s, 1457m, 1400w, 1350w, 1150w, 1130w $cm^{-1.}$ [Found: C, 84.6; H, 9.2; N, 6.8 M 214. $C_{15}H_{19}N$ requires C, 84.5; H, 8.9; N, 6.6. MS (FAB) m/z 215 (M+1)98%]. Metellocene (**25a**) was obtained on reaction of $TiCl_3.3THF$ with (**24**), MS (FAB) m/z 263 (M + 1) while reaction with $ZrCl_4.2THF$ afforded metellocene (**25b**) MS (FAB) m/z 306 (M + 1).



Scheme 7: Synthesis and metallation of 4-(2-cyclopentadienylethyl)pyrrolidine **(28)**

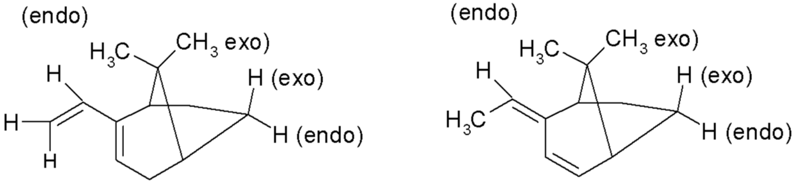
2.9 Synthesis of 4-(2-cyclopentadieylethyl) pyrrolidine (**26**) using 4-(2-chloroethyl) pyrrolidine (**23**) was not possible after several attempts hence compound (**23**) was converted to compound (**27**) 4-(2-iodoethyl) pyrrolidine. The treatment of 4-(2-iodoethyl) pyrrolidine (**27**) with cyclopentadienidesodium at reduced temperature afforded the crude 4-(2-cyclopentadieylethyl) pyrrolidine (**26**) after work-up. The combined ether layer was dried, concentrated and fractionally distilled under reduced pressure in sand bath gave the desired product as a mixture of two isomers (**26a** and **26b**), b.p. (98-104^{o}C/1mm Hg), yield (5.7g. 0.036mol, 79%). ^{1}H NMR (300 MHz, $CDCl_3$) δ 1.7 (s, 4H, H_9 and H_{10}), 2.4 (s, 4H, H_1 and H_2), 2.7 (s, 4H, H_8 and H_{11}), 2.8 (d, 2H, J 3.4Hz, H_{4a} or H_{6b}), 5.9-6.3 (complex, 3H, olefinic) ppm. ^{13}C NMR (70MHz, $CDCl_3$) δ 23.5, (C_9); 29.8 and 30.2, (C_2); 41.3 and 43.3 (C_{4a} or $_{6b}$); 54.5 (C_8); 55.6 and 56.5 (C_1); 126.3 and 126.7 (C_{5a} or $_{5b}$); 130.5 (C_{6a} or $_{4b}$); 134.6 (C_{7a} or C_{7b}); 145 and 147.4 (C_3) ppm. [Found: C, 81.3; H,10.5; N,8.8. M 164 $C_{11}H_{17}N$ requires C, 81.0 H, 10.4; N, 8.6; M(FAB)m/z: 165 (M+1)]. IR ν_{max} (neat) 3040m, 2930m, 2740w, 2695w, 1600w, 1450w (C-N), 1100m, 1095 (C-N) cm$^{-1.}$ Metellocene (**28a**) 4-(2-cyclopentadieylethyl) pyrrolidinetitanium dichloride was obtained on reaction of $TiCl_3$.3THF with (**26**), MS (FAB) m/z 213 (M + 1) while reaction with $ZrCl_4$.2THF afforded metellocene (**28b**) 4-(2-cyclopentadieylethyl) pyrrolidinezirconium dichloride, MS (FAB) m/z 256 (M + 1).



Scheme 8: Synthesis and methylation of (1R)-9,9-dimethyltricyclo[6.1.1$0^{2,6}$]deca-2,5-diene (**33**)
X = a = tosylate and X = b= mesylate

2.10 The yield of a yellow hydrocarbon (**33**) was 2.2g, (83%). ^{1}H NMR (300 MHz, CDCl$_3$) δ: 0.70 (s, 3H, H$_{12}$), 0.80 (d, 1H, J 7.5Hz, H$_{10\text{-endo}}$), 1.2 (d, 1H, J 7.5Hz, H$_{10\text{-exo}}$), 1.33 (s, 3H, H$_{11}$), 2.11 (m, 1H, H$_1$), 2.60 (m, 1H, H$_8$), 2.70 (m, 2H, H$_7$), 2.90 (s, 2H, H$_4$), 5.70 (s, 1H, H$_5$), 5.99 (s, 1H, H$_3$); ^{13}C NMR (70 MHz, CDCl$_3$) δ: 21.7 (C$_{12}$), 26.2 (C$_{11}$), 26$_2$.6 (C$_8$), 28.2 (C$_1$), 32.6 (C$_9$), 40.9 (C$_6$), 41.4 (C$_{10}$), 44.1 (C$_4$), 120.3 (C$_2$), 125.3 (C$_5$), 142.0 (C$_3$), 152.5 (C$_7$). 1R(neat) ν_{max}3311m (C=C), 3063w, 2919 (-CH), 2833w, 2755w, 2360w, 1752w, 1701s, 1619s, 1571s, 1466m, 1383s (CH_3), 1352s, 1263s, 1101, 976s, 901s, 859m, 803m, 761s cm-1. [Found: C, 90.0; H, 10.1. M 160. $C_{12}H_{16}$ requires C, 90.0; H, 10.0 MS (FAB) m/z 161 (M+1).

Methylation of (1R)-9,9-dimethyltricyclo[6.1.102,6]deca-2,5-diene (**33**) afforded the diene (**35**) as a yellow oil (0.61g, 58%). The yield of a yellow hydrocarbon (**30**) was 2.2g, (83%). ^{1}H NMR (300 MHz, $CDCl_3$) δ: 0.72 (s, 3H, H_{11}), 1.24 (d, 1H, J 7.7Hz, $H_{10\text{-endo}}$), 1.33 (s, 3H, H_{12}), 1.60 (d, H_1, J 7. 7Hz, $H_{10\text{-exo}}$), 2.11 (m, 1H, H_1), 2.60 (s, 1H, H_{13}), 2.70 (m, 2H, H2), 3.3 (m, 1H, H_8), 5.70 (d, 1H, J 5.7Hz, H_4), 5.80 (d, 1H, J 5.7Hz, H_5); ^{13}C NMR (70 MHz, $CDCl_3$) δ: 21.7 (C_1), 32.0 (C_{13}), 36.1 (C_{11}), 36.3 (C_{12}), 38.2 (C_8), 38.9 (C_9), 40.5 (C_2), 41.4 (C_{10}), 132.2 (C_5), 134.6 (C_4), 140.5 (C_7), 144.1 (C_6), 154.5 (C_3). 1R(neat) ν_{max}3311m, 3063w, 2919 (-CH), 2833w, 2755w, 2360w, 1752w, 1701s, 1619s, 1571s, 1466m, 1383s (CH_3), 1352s, 1263s, 1101, 976s, 901s, 859m, 803m, 761s cm-1. [Found: C, 89.8; H, 10.1. M 174. $C_{13}H_{18}$ requires C, 89.7; H, 10.3 MS (FAB) m/z 175 (M+1).



(31)

(36)

Figure 2.

2-Vinyl-6,6-dimethylbicyclo[3.1.1]hept-2-ene (**31**) was synthesised by treating the corresponding tosylate (**30a**) or mesylate (**30b**) with potassium *tert*-butoxide (1:1) in DMSO at 75 ^{o}C for 10h to give 65% yield of (**31**) Paquette and McLaughglan 1968 and Cupas and Roach, 1969. However in our hands, this reaction was not very reproducible. The reaction depended critically on temperature and solvent. If the reaction temperature was slightly below 75 ^{o}C compound (**36**) was obtained as the major product, while a temperature of greater than 75 ^{o}C lead to decomposition of the reaction mixture. This problem was circumvented by changing the solvent system from DMSO to DMF other aprotic solvents were tried, but they were found to lead to decomposition and heating the oil-bath to 110 ^{o}C before lowering the reaction vessel then the tosylate (**30a**) was refluxed for 3h to give 2-Vinyl-6,6-dimethylbicyclo[3.1.1]hept-2-ene (**31**) in 71% yield. Under similar conditions, the mesylate (**30b**) gave the same product in 1 h in 65% yield, but a reaction time of 4 h was required to give an optimum yield of 89%.

The synthesis of metallocenes from their complexes (schemes 1-8) were readily achieved by following the protocols previously established with some modifications Obuzor and Booth, (2005, 2010, 2011 & 2012). These complexes and their metallocenes were fully characterized using micro analysis, infra red, mass spec and NMR. These functional group affairs or transformations ending in product development and the harvesting of twenty-one novel products are the outcome. These products have industrial potentials just as their counterparts (Fig. 1) have been used.

Having dealt with synthetic chemistry and harvested sixteen different new metallocenes with eight complexes and several successfully failed reactions. Failed reactions teach one a lot in synthesis and little did I know then that my failed reactions were success in waiting until I saw these quotes:

"Great success is built on failure, frustration, even catastrophe."~ Sumner Redstone. "Only those who dare to fail greatly can achieve greatly" ~ Robert F. Kennedy. I felt good having assured myself to be an ORGANOMETALLIC CHEMIST which is my training.

Organometallic Chemistry is at the interface between Organic Chemistry and Inorganic Chemistry. I effectively function in both worlds of CHEMISTRY.

3.0. NATURAL PRODUCTS

Mr Chairman Sir, Ladies and Gentlemen. It was a very hot morning in 2004 and there was no light, no water, no liquid nitrogen, no dry ice“cardice”, no vacuum line, no schlenk apparatus, no glove box, no fume cupboard, no transfer neddle nor syring, not even a functional desicator. Necesity is the mother of invention I was told so I had to reinvent and reapply myself having been empowered through synthesis on the skills of extraction, distillation, separation, characterization and analyzation. Where else to go but to alluring **NATURAL PRODUCT CHEMISTRY**; a fascinating field in organic chemistry where I could get in touch with my roots and surroundings in order to explore the vast array of natural products. Two main areas appealed to me which are basically plant utilization for their phytochemicals and hopefully neutraceticals (**PHYTOCHEMISTRY**) then secondly, “fruit conversion” (**OENOLOGY)**.

Phytochemistry is the study of phytochemicals, which are chemicals derived from plants. The predominant functional groups that were involved in this affair are the“alkane, alkene, alcohol and carboxylic acids” in the exploration of fatty acids and essential oils.

Fatty acid is a carboxylic acid with a long aliphatic chain, which is either saturated or unsaturated. Most naturally occurring fatty acids have an unbranched chain of an even number of carbon atoms, from 4 to 28 and are usually derived from triglycerides or phospholipids. Fatty acids are important dietary sources of fuel for animals because, when metabolized, they yield large quantities of ATP. Many cell types can use either glucose or fatty acids for this purpose. Long-chain fatty acids cannot cross the blood–brain barrier (BBB) and so cannot be used as fuel by the cells of the central nervous system; however, free short-chain fatty acids and medium-chain fatty acids can cross the BBB, in addition to glucose and ketone bodies.

Eessential oil is a concentrated hydrophobic liquid containing volatile aroma compounds from plants. Essential oils are also known as **volatile oils**, **ethereal oils**, **aetherolea**, or simply as the **oil of the plant** from which they were extracted, such as clove oil, rose oil etc. An oil is "essential" in the sense that it contains the "essence of" the plant's fragrance—the characteristic fragrance of the plant from which it is derived (https://en.oxford). Essential oils are generally extracted by steam-distillation of the different parts of plants, including the flowers, leaves, bark, roots, resin and peels. Other processes include expression, solvent extraction, absolute oil extraction, resin tapping, and cold pressing. They are used in perfumes, cosmetics, aromatherapy, massage, soaps and other products, for flavouring food and drink, for adding scents to incense and household cleaning products, and natural medicine treatments. Essential oil benefits come from their antioxidant, antimicrobial and anti-inflammatory properties. These healing oils are rapidly growing in popularity because they act as natural medicine without any side effects. Essential oil have been used for thousands of years in various cultures for medicinal and health purposes. They enter the body primarily in three ways—applied to the skin, inhaled, or ingested. Within each of these, there are many different kinds of application methods. For example, it can be applied topically using compresses, sprays, baths, steam, or massaging them into the skin.

The choice of any essential oil depends on the purpose of usage and the most lucrative use of essential oil is in perfumery. Scented formulations (Perfume) are in concentration of 2%–40% essential oils (aromatic compounds) or a blend of extracts, ethanol, and water.

Perfume is a mixture of fragrant essential oils or aroma compounds (also known as an odorant, aroma, fragrance, or flavour, is a chemical compound that has a smell or odour), fixatives and solvents - used to give the human body, animals, food, objects, and living-spaces "a pleasant scent".

Figure 3. *Aspilia africana*

Figure 4. *Ixora coccinea*

Figure 5. *Cananga odorata*

Figure 6. *Plumeriarubra*

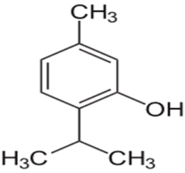


Figure 7. Tymol

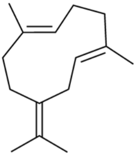


Figure 8. Germacrene b

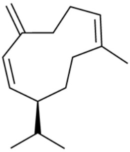


Figure 9. Germacrenes

3.2 My first port of call was my childhood fascination; a weed I used to call the “iodine plant” which was properly identified to be ***Aspilia africana*** (Fig. 3) known as Yurinyun by the Yorubas, Orangila by Igbos, Tozakiby the Hausas, Edemedong by the Efiks

Iwu, 1993 while it’s Uwhoridhoatu in Ekpeye and Ottabi by the Eutung of Cross Rivers State; all of Nigeria, Obuzor and Nkom, 2010. *Aspilia africana* (Pers.) C. D. Adams is a weed of cultivated land and fallows which is widespread in Nigeria as well as several other tropical countries is popularly used as fodder in most villages; has been estabilished as an effective medicinal plant. This weed has green leaves, yellow flowers with six petals Nyananyo, 2008. Evaluation of the potentials of *Aspilia africana* in wound care showed that the leaf extract and fraction sex habited haemostatic, antimicrobial and wound healing activities suggesting that the constituents of the leaves may play a useful role in wound care. The extract and fractions arrested bleeding from fresh wounds by reducing bleeding/clotting and whole blood coagulation time which is important indices of haemostatic activity Achonye, 1976. It is also used to clean the surfaces of sores, in the treatment of rheumatic pains, bee and scorpion stings and for removal of opacities and foreign bodies from the eyes Okoli *et al.*, 2007a. These studies indicate that leaf extracts of *A. africana* have good potentials for use in wound care and further provide a rationale for the use of the leaves of this plant in wound management in traditional medicine practice. Anti-inflammatory activity of hexane leaf extract of *Aspilia africana* has also been reported; Okoli *et al.*, 2007b and Agonihotri *et al.*, 2010. Phytochemical analysis of the extract and fractions indicated the presence of typical plant constituents such as alkaloids, saponins, sterols, terpenoids, carbohydrates, glycosides and tannins Okoli *et al.*, 2007. These metabolites are usually responsible for the pharmacological activities of medicinal plants. The ethnomedicinal uses of this weed stimulated our interest to study the fatty acids, essential oil and some physicochemical properties of *A. africana* for potential application in other areas of health care. Eight fatty acids were identified (gas chromatography, GC) in *A. Africana* Table 1 with two essential fatty acids present in good concentrations (linoleic (C18:2) (ω-6) 50.28% while linolenic is (C18:3) (ω-3) 0.28%)

Obuzor and Nkom, 2010. The essential oil of A. *africana's* major sesquiterpenes are Germacrene d ($C_{15}H_{24}$, 37.98%) with its isomer Germacrene b (21.52%), and *β*-Caryophyllene (13.22%) while 2-carene (5.85%) and thymol (5.91%, a phenol) are the predominate monoterpenes Obuzor and Nkom, 2011. Germacrenes (b and d) are useful because of their antimicrobial and insecticidal properties, though they also play a role as insect pheromones. Thymol ($C_{10}H_{14}O$, 5-Methyl-2-isopropylphenol) is a phenol obtained from thyme oil or other volatile oils. It is used as a stabilizer in pharmaceutical preparations. It has been used for its antiseptic, antibacterial, and antifungal actions, and was formerly used as a vermifuge. *A. africana* is of germacrene d chemotype. We have used *A. africana* extract to impact antiseptic, antibacterial, and antifungal actions in our liquid soap production. *A. africana* liquid soap showed inhibitory effect on *staphylococcus* (>30mm), *pseudomonas* (*15mm)*, and *bacillus* (20mm) Iroh and Obuzor, 2017. This product won the first prize in all Nigerian University Chemistry Students' Exhibition Competition in Abuja during International Year of Chemistry (IYC) in 2011.

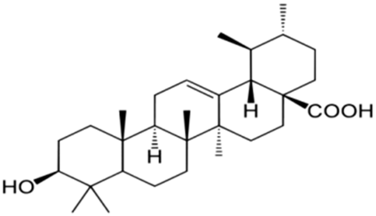


Fig. 10. Ursolic Acid

3.3 ***Ixora coccinea*** (Fig. 4) is a genus consisting of over 500 species in the family *Rubiaceae,* is a tropical evergreen tree and shrub. Though native to the tropical and subtropical areas throughout the world, its centre of diversity is in tropical areas of

Asia, especially India, *Ixora* now grows commonly in subtropical climates in the United States, such as Florida (Ghani, 2003). *Ixora* is commonly known as West Indian Jasmine. Other common names include: rangan, kheme, chann techy, pan, santan, jarum-jarum, jungle flame, and many more Alimuthu, 2008. *Ixora coccinea* is a dense, multi-branched evergreen shrub, commonly 4–6 ft (1.2–2 m) in height, but capable of reaching up to 12 ft (3.6 m) high. It has a rounded form, with a spread that may exceed its height. The glossy, leathery, oblong leaves are about 4 in (10 cm) long, with entire margins, and are carried in opposite pairs or whorled on the stems. Small tubular, scarlet flowers in dense rounded clusters 2-5 in (5–13 cm) across are produced almost all year long. There are many numerous named cultivars differing in colour (yellow, pink, orange) and plant size. Several cultivars are dwarfs, staying under 3ft in height; Nora Grant is a popular dwarf and very suitable for bonsai. This plant of Asian origin was introduced into the Niger Delta area of Nigeria as an ornamental; the various cultivars red, yellow, pink and orange) are used as hedges and for landscaping however the most popular is the red cultivar Nyananyo, 2006.

The efficacy of herbs, roots, leaves and flowers in the treatment of aliments traditionally are mainly attributed to the presence flavonoids, but may also be influenced by other organic and inorganic compounds such as coumarins, phenolic acids and antioxidants micronutrients such as copper (Cu), manganese (Mn), zinc (Zn) etc. Repetto and Liesuy, 2002. *Ixora* leaves are given as treatment in diarrhoea while its flowers are used in the treatment of dysentery, leucorrhoea, dymenorrhoea, hemoptysis and catarrhal bronchitis Ghani, 2003. *Ixora coccinea* flower was reported to have pro-healing actions due to increased collagen deposition as well as better alignment and maturation Nayak *et al.,* 1999. Four fatty acids were identified (gas chromatography, GC) in *I. coccinae* Table 2 with one essential fatty acid an omega-6 (linoleic acid) present in concentration of 35.45%. The essential oil of *ixora coccinea* flower was obtained by hydrodistillation and analysed by Gas Chromatograph (GC) with fifty-four constituents representing 99.97% of the total components of the oil Obuzor and Nwakanma, 2011. The oil is composed mainly of triterpenes 62.60%: (ursolic acid (27.34%), oleanolic acid (20.16%) and lupeol (15.10%), Table 3, monoterpenes 31.73%, sesquiterpenes 3.35% and an ester 2.29%. *Ixora coccinea* flower is of ursolic chemotype. Ursolic Acid (3-*β*-3-hydroxy-urs-12-ene-28-oic-acid, $C_{30}H_{48}O_3$) has anti-inflammatory properties, prevents memory impairment, has anti-cancer properties, antimicrobial properties, liver-protective properties, combinations increase insulin sensitivity, stimulates muscle growth, causes weight loss by increasing body energy expenditure, Akira *et al*., 1994 andhttps://selfhacked.com/2016. It has been effectively used as carrier oil/colourant in our perfume production and as massage oil Obuzor and Nwakanma, 2011.

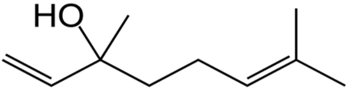


Figure 11: Linalool

3.4 ***Cananga odorata*** (Fig. 8) (Ylang-Ylang) also called chirang, irang (Palau); perfume tree, canagaa (English) and king of the day (Nigeria) is a large evergreen tropical tree of the Annonaceae family, which grows to 100 ft. in height Manner and Elevitch, 2004. It has drooping branches and yellow, long-petaled flowers whose fragrance can be smelled from a distance of 30 ft. or more. It originated in Indonesia and is widely distributed in Southeast Asia, the Philippines, and the Polynesian islands Thaman *et al.*, 2000. The Annonaceae family is comprised of about 130 tropical and subtropical plants, among which are many well-known exotic fruit trees such as the so-called "custard-apples. "These include a sugar apple (*Annonasquamosa*), soursop (*Annonamuricata*), cherimoya (*Annonacherimola*), and *Rolliniadeliciosa*. The family also includes many other fragrant plants, such asdesmos (*Desmo schinensis*) and artabotrys (*Artabotryshexapetalus*) Raulerson and Rinchart, 1991. It is native to Indo-Malaysia and has been widely introduced to by the Polynesians, Micronesians and early Europian explorers into many islands in the Pacific Manner and Elevitch, 2004. Ten fatty acids were identified (gas chromatography, GC) in *Cananga odorata* Table 1; oleic acid (49.39%) with linoleic acid (35.33%) an omega-6 and an essential fatty acid Obuzor and Nweke, 2011. The major commercial product is the oil which is best obtained by hydrodistillation from the freshly picked flowers. Essential oils present are linalool, geranyl acetate, caryophyllene, *p*-cresyl methyl ether, methyl benzoate, benzyl acetate, benzyl benzoate and other sesquiterpenes (Table 3) with benzyl benzoate (16.88%), linalool (27.32%), and benzyl alcohol (22.41%) as the predominant constituents Zhang *et al.*, 2006. Cananga is of linalool ($C_{10}H_{18}O$;3,7-dimethylocta-1,6-dien-3-ol) chemotype. Its essential oil is the major oil of CHANNEL PERFUME and also has homeopathic properties. Cananga oil assists with problems such as high blood pressure, rapid breathing and heartbeat, nervous conditions, as well as impotence and frigidity. Benzyl Alcohol, Benzoic Acid and its salts, and Benzyl Benzoate are used in a wide variety of cosmetics and personal care products, including baby products, bath products, soaps and detergents, eye makeup, blushers, cleansing products, make up products, as well as hair, nail and skin care products. We have utilized its extract in perfuming various products.

- **Burners and vaporizers**
    - In vapour therapy ylang-ylang oil can be helpful with anxiety, tension, shock, fear, panic, rapid breathing, rapid heartbeat, aphrodisiac, physical exhaustion, frigidity, impotence, insomnia, depression and stress.

- **Blended massage oil or in the bath**
  - As a blended massage oil or diluted in the bath ylang-ylang will assist with physical exhaustion, insomnia, frigidity, impotence, depression, anxiety, nervous tension and stress while having a calming and aphrodisiac effect.
- **Cream or lotion**
  - In a cream or lotion it is used to balance the production of sebum in the skin and thereby correcting and balancing overly-dry as well as overly-oily skin.
  -

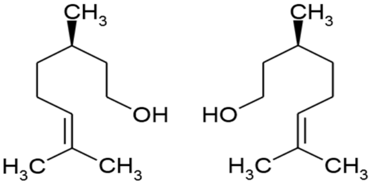


Figure 12: Citronellol

3.5 *Plumeria rubra* (Fig. 6) (common name Frangipani) contains 7-8 species of mainly deciduous shrubs, small trees belonging to the genus *Plumeria* and its common names are Red Frangipani, Common Frangipani, Temple Tree, or simply Plumeria, Genus 2010. Originally native to Mexico, the Caribbean, South America, Central America, Colombia and Venezuela, it has been widely cultivated in subtropical and tropical climates worldwide and is a popular garden and park plant, as well as being used in temples and cemeteries. In modern Polynesian culture, the flower can be worn by women to indicate their relationship status—over the right ear if seeking a relationship, and over the left if taken, http://www.
plumeria. *Plumeria rubra* is the national flower of Nicaragua, where it is known under the local name "*sacuanjoche*" and *plumeria alba* is the national flower of Laos, where it is known under the local name

champa. Frangipani flowers are edible, and can be used in a variety of different dishes such as salads, white or brown rice and prepared as tempura or as onion rings, How to make edible frangipani flowers. The flower can also be made into tea after being sun-dried; the tea has effects of curing fever, wiping out diarrhea, cleaning the lungs and detoxification, http://www.white. Phytochemical analysis of *Plumeria rubra* flower and leaf showed the presence of tannins, phlobatannins, saponins, flavonoids, steroids, terpenoids, cardiac glycosides and reducing sugar from the crude extract while the antibacterial assay showed the methanol extract to inhibit growth of 14 indicator bacteria, Egwaikhide *et al.,* 2007 and Tohar *et al.,* 2006. Essential oil of *P. rubra* contains potent active components for use as semiochemicals or pheromones and other utilizations, Obuzor and Nweke 2011. Fatty acid of *Plumeria rubra* from Port Harcourt, Nigeria was analyzed by gas chromatography and sixteen acids were identified. It was observed that the concentration order of the fatty acids is polyunsaturated (44.72%) > monounsaturated (29.25%) > saturated (26.05%) for *Plumeria rubra*. Ten of the fatty acids were found in trace amounts while palmitic (C16:0) and stearic (C18:0) gave values of 17.82% and 8.23% respectively. The monounsaturated fatty acids oleic (C18:1) an “omega-9” and erucic acid gave values of 24.76% and 4.49% respectively. The polyunsaturated essential fatty acids linoleic (C18:2) an “omega-6” was 39.52% while linolenic (C18:3) an “omega-3” gave a value of 5.20%. *P. rubra* is predominately citronellol (14.63%), nonadecane (15.63), and heneicosane (19.15%) but it’s of the citronellol chemotype as it is its most useful oil component. Citronellol is used in perfumes and insect repellents, and as a mite attractant, Taylor and Schreck, 1985. Citronellol is a good mosquito repellent at short distances, but protection greatly lessens when the subject is slightly further from the source Revay *et al.,* 2013. When complexed with *β*-cyclodextrin, it has on average a 1.5 hour protection duration against mosquitoes Songkro *et al.*, 2011. The results of these analyses strengthen the folklore curative claims on *Plumeria rubra.*

Table 2: Fatty acid concentration (%) of some medicinal plants.

S/No	Acids	*Aspilia africana*	*Plumera rubra*	*Ixora coccinea*	*Cananga odorata*
	Butyric (C5:0)	Trace	Trace	Trace	0.001
	Caproic (C6:0)	Trace	Trace	Trace	0.002
	Caprylic (C8:0)	Trace	Trace	Trace	0.001
	Capric (C10:0)	Trace	Trace	Trace	Trace
	Lauric (C12:0)	Trace	Trace	Trace	Trace
	Myristic (C14:0)	Trace	Trace	Trace	Trace
	Palmitic (C16:0)	Trace	17.82	9.74	12.50
	Palmitoleic (C16:1)	11.70	Trace	Trace	0.28
	Stearic (C18:0)	15.10	8.23	27.85	2.67
	Oleic (C18:1)	**18.85**	**24.76**	**26.95**	**49.39**
	Linoleic (C18:2) (ω-6)	**50.28**	**39.52**	**35.45**	**35.33**
	Linolenic (C18:3) (ω-3)	**0.28**	**5.20**	Trace	0.01
	Arachidic (C20:0)	0.54	Trace	Trace	0.03
	Behenic (C22:0)	2.95	Trace	Trace	Trace
	Erucic (C22:1)	**0.22**	**4.49**	Trace	Trace
	Lignoceric (C24:0)	Trace	Trace	Trace	Trace
	Saturated fatty acids (SFA)	18.59	26.05	37.59	15.15
	Monounsaturated fatty acids (MUFA)	30.77	29.25	26.96	49.39
	Polyunsaturated fatty acids (PUFA)	50.56	44.72	35.45	35.34

Table 3: Predominant essential oil of some medicinal plants.

S/O	Plants	Essential oil
1.	*Aspilia africana*	Germacrene*b* (21.52%), and *β*-Caryophyllene (13.22%) while 2-carene (5.85%) and thymol (5.91%, a phenol)
2.	*Ixora coccinea*	Ursolic acid (27.34%), oleanolic acid (20.16%) and lupeol (15.10%,
3.	*Cananga odorata*	Benzyl benzoate (16.88%), linalool (27.32%), and benzyl alcohol (22.41%)
4.	*Plumera Rubra*	Citronellol (14.63%), nonadecane (15.63), and heneicosane (19.15%)

The retention time for each of these fatty acids is variable as such they can be separated and isolated using the appropriate techniques and equipment as various products for assorted usages. For example, for the production of Lorenzo oil. Lorenzo's Oil is a combination of a 4:1 mix of oleic acid and erucic acid, extracted from rapeseed oil and olive oil designed to normalize the accumulation of the very long chain fatty acids in the brain thereby slowing the progression of adrenoleukodystrophy (ALD), which occurs in children; and adrenomyeloneuropathy (AMN), which occurs in adults. Lorenzo's oil is named after a child, Lorenzo Odone, who developed ALD. His parents discovered a mixture of fatty acids that seemed to slow progression of the disease. The mixture became known as "Lorenzo's oil."

Lorenzo's Oil from our plants:

To 4ml oleic acid (extracted from *Aspilia africana*, *Plumeria rubra*, *Ixora coccinea*, *Gardenia jasminoide* or *Cananga odorata*) in a conical flask containing a magnetic stirring bar was added 1ml erucic acid extracted from *Aspilia africana* or *Plumeria rubra* and stirred gently for 30mins. Transfer to an ember bottle for later usage.

CLASSIFICATION OF PERFUME

- **Parfum** or **extrait**, perfume extract, pure perfume, or simply perfume: 15–40%
- **Esprit de Parfum**: 15–30%
- **Eau de Parfum**: 10–20% (typical ~15%)
- **Eau de Toilette** : 5–15% (typical ~10%) aromatic compounds
- **Eau de Cologne**, often simply called cologne: 3–8% (typical ~5%)

4.0 OENOLOGY

Figure 13. Grapes

Figure 14. *Carica papaya*

Figure 15. *Mangiferaindica*

Figure 16. *Hibiscus sabdariffa (*Roselle)

My functional group affairs' starting material **Tartaric Acid (**2,3-dihydroxybutanedioic acid) (**1**) is a white crystalline organic acid that occurs naturally in many plants, most notably in grapes (Fig. 13). Its salt, potassium bitartrate, commonly known as cream of tartar, develops naturally in the process of winemaking. It is commonly mixed with sodium bicarbonate and is sold as baking powder used as a leavening agent in food preparation. The acid itself is added to foods as an antioxidant and to impart its distinctive sour taste. Tartaric is an alpha-hydroxy-carboxylic acid, is diprotic and aldaric in acid characteristics, and is a dihydroxyl derivative of succinic acid. Tartaric acid may be most immediately recognizable to wine drinkers as the source of "wine diamonds", the small potassium bitartrate crystals that sometimes form spontaneously on the cork or bottom of the bottle. These "tartrates" are harmless, despite sometimes being mistaken for broken glass, and are prevented in many wines through cold stabilization. The tartrates remaining on the inside of aging barrels were at one time a major industrial source of potassium bitartrate. Tartaric acid plays an important role chemically by lowering the pH of fermenting "must" to a level where many undesirable spoilage bacteria cannot survive, and acting as a preservative after fermentation. In the mouth, although citric and malic acids also play a role, tartaric acid provides some of the tartness in **WINE**.

"WINE" in English and in translation is reserved exclusively for the fermented juice of grapes within the European Union, Harding 2005. However, within the United States of America, wine may include the fermented juice of any fruit or agricultural product, provided that it is between 7% and 24% alcohol by volume and intended for non-industrial use, Electronic 2013. **WINE** is an alcoholic beverage made with the fermented juice of grapes or technically, wine can be made with any fruit. With the exceptions of cider, perry, and saké; non-grape wines are usually named after it’s fruit qualifying it by a truthful description of the originating product such as "honey wine", "dandelion wine", (blended) "fruit wine", etc, Electronic 2013.

Cider is an alcoholic beverage made from the fermented juice of apples.

Perry is a similar product made from fermented pear juice.

Saké is a Japanese rice wine made by fermenting rice that has been polished to remove the bran.

Oenology is the science and study of wine and winemaking. It is an artistic creation that gives the signature of each oenologist and it has been observed that chemist make the best oenologist. An **oenologist** is an expert in the fields comprehended by the “Viticulture and Oenology” designation for oenology-training programmes and research centres that include schooling, training, and education in the outdoor and indoor aspects of wine and the production of wine. An increasing number of schools offer degree-granting programs in Oenology and Viticulture. Most of these offer it as a major concentration for a Bachelor of Science (B. Sc.) degree or offer it as a terminal master's degree either in scientific or research oriented program culminating in a Master of Science (M. Sc.) degree, or a professional degree. Oenologists and viticulturalists who hold doctoral degrees often have earned them in related fields, including horticulture, plant physiology or microbiology. Related non-academic titles including sommelier and Master of Wine certifications are more oriented toward commercial occupations in the restaurant or hospitality management industry.

Wine has importance in many social and religious contexts in our society today, as it has for thousands of years. People have been drinking wine for more than 5,000 years. This $26 billion a year industry in the United States is much more than just a flavorful beverage that compliments dinner; that is, wine also has proven health benefits. Red wine is rich in flavonoids and it may protect your heart by reducing low-density lipoprotein (LDL: bad cholesterol), increasing high-density lipoprotein (HDL: good cholesterol), and reducing blood clotting. Additionally, white wine can help to improve lung function.

Wine production is an annual event that spans the globe, resulting in numerous varieties to choose from. Regardless of location (e.g., France, Italy, United States etc.), the wine making process remains the same as outlined below.

Step 1: CRUSHER - Grapes are conveyed to a de-stemmer/crusher where grape leaves and stems are removed, and grapes are crushed.

Step 2: FERMENTATION - Most red grapes go to the fermenter for primary fermentation while most white grapes are pressed prior to fermentation. Yeast is added to start the fermentation.

Step 3: PRESS - After fermentation, red wines go to press to separate the wine from the grape skins.

Step 4: TANK - Most wines are settled in large stainless steel or upright oak tanks.

Step 5: BARREL - After settling, red wines and fuller-bodied white wines are put into small oak barrels for barrel aging.

Step 6: FILTER - After barrel aging and prior to bottling, some wines are filtered to help stabilize and clarify them.

Step 7: BOTTLE - Finished wines are bottled.

Step 8: AGING - (OPTIONAL) Wines may be aged further in a bottle.

The basic fermentation process whereby alcohol is produced from the sugar in grapes is very simple, but its chemistry is still not completely understood. As this knowledge increases, winemakers are being helped to improve the quality of their wine. Grape juice consists of 79% water and 20% carbohydrates, 1% organic acids and trace amounts of organic acids, phenolics, vitamins, minerals and nitrogenous compounds. The sugars, organic acids and phenolics give the juice its flavour, while the vitamins, minerals and nitrogenous compounds are, in many cases, essential to yeast growth and fermentation.

The major problems in wine production, however, arise from the difficulty in extracting the sugar from the pulp of some of the fruits, or finding that the juices obtained lack in the requisite sugar contents, have higher acidity, more anthocyanin, or have poor fermentability. Sugars in wine are at the heart of what makes winemaking possible. During the process of fermentation, sugars from wine grapes are broken down and converted by yeast into alcohol (ethanol) and carbon dioxide.

$$\mathbf{C_6H_{12}O_6 \rightarrow 2C_2H_5OH + 2CO_2}$$

Very high sugar content will effectively kill the yeast once a certain (high) alcohol content is reached. For these reasons, no wine is ever fermented completely "dry" (meaning without any residual sugar). Sugar's role in dictating the final alcohol content of the wine sometimes encourages winemakers to add sugar (usually sucrose) during winemaking in a process known as chaptalization solely in order to boost the alcohol content Robinson, 2006. Chaptalization is illegal in California and in Bordeaux wine region, France. Wine has a similar composition as grape, but has much lower levels of sugar (none in dry wines), 8 - 13% alcohol and a greater range of minor components hence using any fruit must be chosen with care.

Wine and its related products have been consumed since ancient times, not only for stimulatory and healthful properties, but also as an important adjunct to the human diet by increasing satisfaction and contributing to the relaxation necessary for proper digestion and absorption of food. Most wines are produced from grapes throughout the world, however, fruits other than grapes, including apple, plum, peach, pear, berries, cherries, currants, apricot, and many others can also be profitably utilized in the production of wines. The utilization of fruits other than grapes is in part due to:

- Focuses on producing non-grape wines, highlighting their flavor, taste, and other quality attributes, including their antioxidant properties
- Provides a single-volume resource that consolidates the research findings and developed technology employed to make wines from non-grape fruits
- Explores options for reducing post-harvest losses, which are especially high in developing countries
- Stimulates research and development efforts in non-grape wines

Table 4: International Synonym of *Carica papaya* Linn.

1.	**Country**	**Names**
2.	India	Papita
3.	Holland	Tree melon
4.	France	Papaya
5.	Australia	Paw paw
6.	Brazil	Mamao
7.	UK	Papaya, Paw paw

Papaya (*Carica papaya* Linn) commonly called paw-paw (Fig. 14) in Nigeria; belongs to the *Caricaceae* family; is one of the valuable plants used for various purposes in ethno medicine and Table 3 lists other common names of *Carica papaya (*Mantok, 2005). During the last few decades considerable progress has been achieved regarding the biological activity and medicinal application of papaya and now it is considered as valuable nutraceutical fruit plant. Papaya possesses excellent medicinal properties for treatment of different ailments. The different parts of the *Carica papaya* plant including leaves, seeds, latex and fruit are known to have medicinal value. The stem, leaf and fruit of papaya contain plenty of latex. The latex from unripe papaya fruit contains enzymes papain and chymopapain. Papaya fruit is a rich source of nutrients such as provitamin A, carotenoids, vitamin C, vitamin B, lycopene, dietary minerals and dietary fibre.

Nigeria is the third largest producer of pawpaw but exports none, Mexico the fifth largest producer is the number one exporter of pawpaw while USA the number one importer of pawpaw is the third exporter of pawpaw products (Tables 5-7).

Table 5. Word production of papaya (FAOSTAT)

Country	**Production (Tonnes)**		**Are Harvested (Ha)**		**Yield**	
	2004	**2008**	**2004**	**2008**	**2004**	**2008**
India	2,535,100	2,685,900^2	73,800	80,300^2	34,4^3	33.4^3
Brazil	1,612,348	1,900.000^2	34,445	36,750^2	46.8^3	51.7^3
Nigeria	755,000^2	765,000^2	91,000^2	92,500^2	8.3^3	8.3^3
Indonesia	732,611	653,276	9,134	8,982	80.2^3	72.7^3
Mexico	787,663	638,237	20,610	16,084	38.2^3	39.7^3
Ethiopia	260,000^2	260,000^2	12,500^2	12,500^2	20.8^3	20.8^3
Congo, DR	214,070	223,770^2	12,712	13,500^2	16.8^3	16.7^3
Colombia	103,870	207,698	4,464	5,498	23.3^3	37.8^3
Guatemala	84,000^2	184,530^2	2,100^2	3,500^2	40.0^3	52.7^3
Philippines	133,876	182,907	8,969	9,175	14.9^3	19.9^3
Peru	193,923	157,771^2	13,449	11,043^2	14.4^3	14.3^3
Venezuela	131,753	132,013^2	7,103	7,107^2	18.5^3	18.6^3
China	157,620^1	120,359^2	5,743^1	5,826^2	27.4^3	20.7^3
Thailand	125,000^2	131,000^2	10,500^2	11,000^2	11.9^3	11.9^3
Cuba	119,000	89,400	6,088	4,006	19.5^3	15.0^3

Table 6. World papaya export (FAOSTAT)

Country	**Export Value (100 $)**		**Export Quantity (Tonnes)**	
	2004	**2007**	**2004**	**2007**
Mexico	72,722	55,327	96,525	101,306
Brazil	26,563	34,404	35,930	32,267
United States	15,917	17,715	9,789	9,604
Netherlands	17,4201	16,907	9,554	8,625
Belize	17,429[1]	13,101	28,751[1]	33,341
Malaysia	21,893	8,407	58,149	26,938
Philippines	4,182	6,374[1]	3,324	4,880[1]
France	2,802	3,766	1,307	1,830
Cote d’ Ivoire	671	3,203	1,048	5,296
Spain	1,269	2,748	1,464	1,637
Jamaica	2,124	2,721	1,229	1,340
India	1,119	2,525	3,475	10,880
Costa Rica	482	2,721	579	2,972
Ecuador	2,057	2,383	7,196	5,486
China	817	2,277	4,455	10,067
Dominican Republic	741[1]	2,108[1]	1,515[1]	5,200[1]
Guatemala	372	1,372	1,069	6,680
Fiji	644	1,254	303	470
Germany	1,881	1,029	1,084	442
Belgium	3,004	800	980	527

Table 7. World Papaya import (FAOSTAT)

Country	**Import value ($1000)**		**Import quantity (Tonnes)**	
	2004	**2007**	**2004**	**2007**
United States	94,844	73,125	126,024	138,115
Netherlands	19,305	19,208	15,432	12,569
United Kingdom	18,422	18,231	11,108	8,588
Canada	11,965	17,987	10,324	14,487
Germany	16,433	16,873	10,581	8,155
Portugal	8,909	12,932	5,682	5,992
Spain	5,849	11,695	3,541	6,686
Japan	12,547	9,497	4,763	3,996
France	4,906	8,533	2,048	3,414
China, Hong Kong SAR	11,953	5,075	25,972	9,800
Italy	3,343	4,097	1,630	2,008
Singapore	4,224	4,040	24,606	19,086
Switzerland	3,118	3,628	1,345	1,339
United Arab Emirates	1,371[1]	1,847[1]	3,152[1]	6,315[1]
New Zealand	734	1,620	393	874
Sweden	1,350	1,460	603	580
Belgium	2,247	1,392	1,302	847
Austria	833	1,190	466	406
China	3,582	1,126	4,734	1,411
Norway	292	1,016	95	293

[1] Estimated data using trading partner's database *Sources:* FAOSTAT

Papain, enzyme present in the leaves, latex, roots, and fruit of the papaya plant (*Carica papaya*) that catalyzes the breakdown of proteins (as in tenderizing meat) is also used in biochemical research involving the analysis of proteins, in clarifying beer, in removing hair from hides before tanning, and in enzyme-action cleansing agents for soft contact lenses. It is also used in toothpastes and cosmetics and in preparations of various remedies for indigestion, ulcers, fever, and swelling. The amount and activity of papain isolated from the different parts of the papaya plant vary depending on the age of the tree and whether it is male or female. For example, higher quantities

of crude papain may be extracted from female trees compared with male trees and from older fruits compared with younger fruits. However, papain extracted from young papaya fruit produced by female trees typically is more active than that extracted from old fruit produced by male or hermaphrodite plants. Papain can trigger allergic reactions in susceptible individuals. Skin reactions may occur following contact with fresh latex from papaya; hypersensitivity reactions may be especially pronounced in persons allergic to latex [https://www.britannica.com/science/papain].
CHYMOPAPAIN is an enzyme used to shrink or dissolve ruptured disks in certain kinds of lumbar spine injuries, and otherwise as a digestant of protein.

Nutritionally, the major components of pawpaw juice consist of 89% water and 9.7% carbohydrates (Chukwuka *et al.,* 2013). The total dietary fibre content of ripe fruit varies from 11.9 to 21.5 g/ 100 g/ dry matter (Puwastien *et al.,* 2000; Saxholt *et al.*, 2008 and Chukwuka *et al.,* 2013) crude protein ranges from 3.74 to 8.26g/100 dry matter (Chukwuka *et al.,* 2013). The sugars (9.7%), organic acids and phenolics give the juice its flavour, while the vitamins, minerals and nitrogenous compounds are, in many cases, essential to yeast growth and fermentation (Chukwuka *et al.,* 2013). *Carica papaya* which has most of the attributes of grape has been used to produce white wine of 14% alcohol by using the six basic steps of wine production with little modifications.

4.3 *Mangifera indica* (Fig. 15) also known as Mangoes belong to genus *Mangifera* which consists of about 30 species of tropical fruiting trees in the flowering plant family *Anacardiaceae* and varied medicinal properties are attributed to different parts of mango tree. The juice is restorative tonic and used in heat stroke. The seeds are used in asthma and as an astringent. Fumes from the burning leaves are inhaled for relief from hiccups and affections of the throat. The bark is astringent, it is used in diphtheria and rheumatism, and it is believed to possess a tonic action on mucus membrane. The gum is used in dressings for cracked feet and for scabies. It is also considered anti-syphilitic. The kernels are converted into flour after soaking in water and eliminating the astringent principles. Most parts of the tree are used medicinally and the bark also contains tannins, which are used for the purpose of dyeing. Ripe mango fruit is considered to be invigorating and freshening.

4.4 *Hibiscus sabdariffa* (**Roselle)** Figure 16 is a species of *Hibiscus* probably native to West Africa, used for the production of bast fibre and as an infusion, in which it may be known as **carcade**. It is an annual or perennial herb or woody-based subshrub, growing to 2–2.5m (7–8ft) tall. The leaves are deeply three- to five-lobed, 8–15cm (3–6in) long, arranged alternately on the stems.

The flowers are 8–10cm (3–4in) in diameter, white to pale yellow with a dark red spot at the base of each petal, and have a stout fleshy calyx at the base, 1–2cm (0.39–0.79in) wide, enlarging to 3–3.5cm (1.2–1.4in), fleshy and bright red as the fruit matures. They take about six months to mature.

The *Hibiscus* leaves are a good source of polyphenolic compounds. The major identified compounds include neochlorogenic acid, chlorogenic acid, cryptochlorogenic acid, caffeoylshikimic acid and flavonoid compounds such as quercetin, kaempferol and their derivatives Zhen *et al.*, 2016. The flowers are rich in anthocyanins, as well as protocatechuic acid. The dried calyces contain the flavonoids gossypetin, hibiscetine and sabdaretine. The major pigment, formerly reported a shibiscin, has been identified as daphniphylline. Small amounts of myrtillin (delphinidin 3-monoglucoside), chrysanthenin (cyanidin 3-monoglucoside), and delphinidin are present. Roselle seeds are a good source of lipidsoluble antioxidants, particularly gamma-tocopherol, Mohamed *et al.,* 2007. Protocatechuic acid (3, 4-dihydroxybenzoic acid) is a natural phenolic compound found in many edible and medicinal plants. Recent studies indicate that it could be used as a protective agent against cardiovascular diseases and neoplasms. The mechanism of its action is mostly associated with antioxidant activity, including inhibition of generation as well as scavenging of free radicals and up-regulating enzymes which participate in their neutralization.

CLASSIFICATION OF WINE

Historically, wines have been classified by names reflecting their origin, and sometimes style: Bordeaux, Port, Rioja, Mosel and Chianti are all legally defined names reflecting the traditional wines produced in the named region. These naming conventions or "appellations" (as they are known in France) dictate not only where the grapes in a wine were grown but also which grapes went into the wine and how they were vinified. The appellation system is strongest in the European Union, but a related system, the American Viticultural Area (AVA), restricts the use of certain regional labels in America, such as Napa Valley, Santa Barbara and Willamette Valley. The AVA designations do not restrict the type of grape used. Classification can be by vinification methods and style to give wines such as Sparkling, Still, Dessert, Fortified, Table, Cooking wine or cooking sherry

Nigeria is a wine consuming than a wine producing country where the value of Nigeria’s wine importation industry reached US$370 million by 2015, as Nigerians develop a thirst for high end wine and spirits https://2012 wine/. There is the need for the conversion of the high volume of fruits produced in this country to value added product such as WINE.

PRODUCTION OF UKALINA WINES (WHITE AND RED).

$$C_6H_{12}O_6 \longrightarrow 2C_2H_5OH + 2CO_2$$

This equation is ("My own very personal equation and I strongly feel that every chemist should have their own personal equation") where carbohydrate is broken down by the action of yeast in the presence of suitable additives to yield a product (functional groups involved here are the -OH and –C=O). Utilizing *Mangifera indica, Carica papaya* and *Hibiscus sabdariffa* which are abundant in Nigeria, Ukalina Wine (Fig. 17) with 12-14% alcohol have been produced and aged. These wines are quite comparable to most imported wines. Oenotourism is a high value spin off of oenology.

Figure 17. Ukalina Wines (CSN 2016 First Prize winner).

Ukalina Wines (fig. 17) won the first position at the Chemical Society of Nigeria (CSN) 39th Annual International, Exhibition Workshop and Conference held in Port Harcourt in September 2016 tagged "Garden City 2016".

5. WASTE TO WEALTH

Aluminum cans, or polyethylene terephthalate (PETE), are used as storage containers in one form or the other. Aluminum is one of the most indestructible materials used as metal containers with an average “life” of about one hundred years. Although aluminum is the third most abundant element in the earth’s crust, the expense of extracting it from common soils is too expensive and the major source is the ore *bauxite*, the hydrated form of aluminum oxide, $Al_2O_3 \cdot 2H_2O$. Although there is concern regarding the depletion of aluminum ores, the major concern is the amount of electrical energy needed to extract the aluminum from its ores. To produce a single can, the energy needed is about the same as that required to keep a 100-wattbulb lit for 6 hours. That energy can be reduced by up to 95 percent by recycling used aluminum cans. Recycling also has the benefit of reducing litter from discarded cans.

Figure 16. Alum from aluminumcan(CSN 2016 2^{nd}Prize winner).

Our conversion of aluminum cans to potassium aluminum sulfate (alum) (fig. 18) won the second position at the Chemical Society of Nigeria (CSN) 39th Annual International, Exhibition Workshop and Conference held in Port Harcourt in September 2016 tagged “Garden City 2016”.

$$\mathbf{2Al(s) + 2KOH(aq) + 4H_2SO_4(aq) + 22H_2O(l) \rightarrow 2KAl(SO4)_2 \cdot 12H_2O(s) + 3H_2(g)}$$

Currently, one of our research focuses is the production of bitters from some fascinating natural products by fermentation process.

CONCLUSION:

Mr. Vice-Chancellor Sir, Ladies and Gentlemen. The Vice Chancellor of University of Uyo, Prof. Comfort Ekpo in their 45th Inaugural Lecture in June 2015 noted that any professor who has not presented his or her inaugural lecture is indebted to the university system."***Veni, vidi, vici***" (I came, I saw I conquer) not by my power but God’s alone. In my moment of strife a good friend of mine said to me “In everything give thanks: for this is the will of God in Christ Jesus concerning you” (1Thessalonians 5:18). Let it be told: I HAVE PAID MY DEBT and I give thanks to Almighty God. In seven years’ time I will be retiring from the University system and because of my functional group affairs and it’s pathway to product development I shall not retire into POVERTY.

RECOMMENDATIONS:

Mr. Vice-Chancellor Sir, permit me to paraphrase Prof A. I. Olayinka, the Vice-Chancellor of University of Ibadan. “After independence, in order to build a great nation, each country went to work. But Nigeria went into prayer, fasting, speaking in tongue, binding and casting while”: Denmark (Education), Malaysia (Palm tree), Singapore (Investment in Technology), India (ICT), China (Massive Industrialization), UAE (Massive Infrastructural Development). These countries were rewarded accordingly. Uniport should scale up these viable products in proper partnership with the researchers.

- Properly equip laboratories not for accreditation purposes alone but permanently for meaningful research.
- Revive this University’s Annual Research Fair and Conference; and to also participate in the Annual National University Research Fair.
- Provide regular in-service training for staff.
- Develop Uniport garden where relevant plants should be planted for product development.

- **UGO! UGO!! UGO!!!**

Thanks for your attention and listening.

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CITATION ON

PROFESSOR GLORIA UKALINA OBUZOR

B. Sc. (UDC), M. Sc. (UPH), Ph. D (UMIST)

Mr. Vice-Chancellor Sir. I feel privileged to read the citation on the 1st female and the sixth Professor to deliver an inaugural lecture in the Department of Pure and Industrial Chemistry, University of Port Harcourt. Prof. Gloria Ukalina Obuzor was born on 22nd April, 1954 in Ahoada in Ahoada East Local Government Area of Rivers State to Mr Upadibe Israel Ekpahulu Ideozu and Mrs. Rhoda Ideozu (nee Esukpa of Odiabidi Village in Ahoada East Local Government Area; (both late).

Prof. Obuzor had her secondary education at Holy Rosary Secondary School, Port Harcourt, Rivers State with a Shell, BP scholarship, a B. Sc. in Chemistry at University of the District of Columbia (UDC), Washington, D. C., USA with a River State scholarship, an M. Sc. at University of Port Harcourt (Uniport), Port Harcourt, Rivers State, Nigeria with Uniport sponsorship and a Ph. D. at University of Manchester Institute of Science and Technology (UMIST), Manchester, UK with Commonwealth Scholarship. She served her National Youths Service Corps (NYSC) in 1981 at the Department of Pure and Industrial Chemistry, University of Port Harcourt and was retained by the University after her NYSC service as a Graduate Assistant. She went through the rank and file to become a Professor in 2012. Her major research interests are in: Organic synthesis, Phytochemistry and Oenology. She has passion for product development and she is the proud producer of Ukalina Wines (White and Red). Her product liquid soap with modified chemical content won the first prize in an all Nigerian University Research Competition organized by the Chemical Society of Nigeria (CSN) in 2011 during the International Year of Chemistry (IYC 2011). Her products: Ukalina wine won the first position while her waste to wealth product took the second position in 2016 during the International Conference, Workshop and Exhibition of the Chemical Society of Nigeria (CSN) tagged “Garden City 2016”.

Prof. Obuzor the current Head of Department of Pure and Industrial Chemistry has served University of Port Harcourt in several capacities as member: Junior Staff Committee, Housing Committee, Research Fair Committee, and Representative of Faculty of Science at Faculty of Education. She has also served different Universities in several capacities as external examiner for Undergraduate, Postgraduate Programs and External Assessor for Professorial candidates. She is the Vice-President, Federation of African Society of Chemist (FASC), member: American Chemical Society, Royal

Society of Chemistry and Committee of Chemical Education of IUPAC. Prof. Obuzor who joined the Chemical Society of Nigeria (CSN) in 1986 became a life member in 1991 and a Fellow in 2008. She was the first female Chairman of CSN and is the first female President of CSN in its forty-six years of existence. She has served the Society in the following capacities:

- (2001-current) Member of Council
- (2001-2005) National Treasurer.
- (2003-2007) Chairman Rivers/Bayelsa States.
- (2005-2014) Chairman, Awards and Educational Committee
- (2011-2014) National Vice-President.
- (2014-current) PRESIDENT, Chemical Society of Nigeria.

Prof. Obuzor is happily married to Arc. Nnamdi O. Obuzor of Odiokwu Village in Ahoada West LGA and their marriage is blessed with six children (two girls and four boys).

Vice- Chancellor Sir, I present to you an amiable, humble, God-fearing Academic, Vice-President (FASC), the FIRST FEMALE PRESIDENT OF THE CHEMICAL SOCIETY OF NIGERIA, THE FIRST FEMALE INAUGURAL LECTURER OF HER DEPARTMENT, THE FIRST FEMALE PROFESSOR OF CHEMISTRY IN RIVERS STATE, A PACE SETTER to present the 143rd Inaugural Lecture of the University of Port Harcourt, Prof Gloria Ukalina Obuzor

Prof. Victory Uche Dienye
Orator