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**F PHYSICAL SCIENCES BIENNIAL**

**INTERNATIONAL CONFERENCE**

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**SPSBIC**

**2021)**

PROCEEDINGS

25

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28

th

October, Minna Nigeria

**THEME:**

**THE ROLE OF SCIENCE AND TECHNOLOGY IN THE**

**REALIZATION OF RESEARCH AND DEVELOPMENT IN THE**

**ERA OF GLOBAL PANDEMIC**

**FEDERAL UNIVERSITY OF TECHNOLOGY MINNA,**

**NIGER STATE, NIGERIA**

**PREFACE**

It is a great privilege for us to present the proceedings of 3rd School of Physical Sciences Biennial International Conference (SPSBIC) 2021 devoted to the role of science and technology in the realization of research and development in the era of pandemic. We hope that authors, delegates, agencies other individuals will find this compilation very useful and inspiring.

The school of Physical Sciences 3rd Biennial International Conference is an interdisciplinary forum for the presentation of new ideas, recent developments and research findings in the field of Science and Technology. The Conference provides a platform to scholars, researchers in the academics and other establishments to meet, share and discuss on the role of science and technology in the realization of research and development in the era of pandemic. Submissions were received both nationally and internationally and severally reviewed by our international program committee. All contributions received were neither published elsewhere nor submitted for publication as asserted by contributors.

This conference brought together experts from varying fields, visions, knowledge and experience with potentials; pre-conference workshop and four keynote speakers with world class experience in varying fields of specialization in addition to over 150 scientific participants who unveiled the latest scientific evidence to boost contemporary scientific and technological research development in the era of pandemic.

The success of the conference was a function of the collective efforts of numerous individuals. Our profound gratitude goes to the Dean School of Physical Sciences

Prof. Jonathan Yisa for putting the trust the in us to serves as the Local Organizing Committee (LOC). The Vice Chancellor Prof. Abdullahi Bala and the entire management team for their unflinching support that led to the success story. We are most grateful to our workshop facilitator and his team as well as our keynote speakers for accepting our invitations and travelled long distances to be with us at no cost to the University. We also acknowledge the participants themselves, without whose expert input there would have been no conference. Thank you all for your contributions.

**Prof. A. Abdulkadir**

Chairperson Local Organizing Committee

# THEME OF THE CONFERENCE

The Role of Science and Technology in the Realization of Research and Development in the Era of Global Pandemic

# SUB-THEMES OF THE CONFERENCE

* Sustainable Management of Pandemic
* Global Change, Responses and Strategies for Limiting Pandemic
* Modelling and Monitoring of Pandemic
* Science, Technology, Engineering and Mathematics as Leveraging tools for Management of Pandemic

# PRE-CONFERENCE WORKSHOP TITLE

Isolation, Purification and Structural Elucidation of Compounds and Drug Testing on Animals

**Local Organizing Committee Members**

Prof. (Mrs) A. Abdulkadir (Chairperson)

Dr. M. I. Kimpa

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Dr. U. Mohammed

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Dr. A. N. Amadi

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**Logistic Committee**

Dr. S. Ojoye

Dr. A. A. Rafiu

Dr. M. I. Kimpa

Dr. A. A. Ahmed

Dr. A. N. Amadi

## KEYNOTE SPEAKERS



**Dr. H. A. Shaba**

Dr. Halilu Ahmad Shaba was a Director, Strategic Space Applications Department (SSA), National

Space Research and Development Agency (NASRDA) as well as HOD, Department of Geo-informatics & GIS Applications, Institute of Space Science and Engineering (ISSE) affiliate of Africa University of Science and Technology (AUST), Abuja.

Dr. Shaba has successfully overseen and implemented over 20 projects among which are:

* Mapping the Drivers of Deforestation and Forest Degradation in Cross River State, Nigeria (Sponsored by FAO)
* Erosion Mapping and Monitoring with Space Technology in South-East and South-South Nigeria (Sponsor by World Bank via NEWMAP).
* Monitoring deforestation and forest degradation in cross river state, Nigeria (Part of the implementation of the UN-NEDD program in Nigeria)
* National Personnel Audit Geospatial Digital Database Development: Sponsor by UBEC
* Geo-referenced Infrastructure and Demographic Data for Development (Grid3) Project in Nigeria (NASRDA, eHealth Africa, Centre for International Earth Science Information Network (CIESIN) USA and Novel T)
* Engagement for harmonization of health facilities database (Phase 1: Geospatial Tracking System (GTS): (Ministry of health, National Primary Health Care Development Agency collaborating with National Space Research & Development Agency, eHealth Africa Foundation and Novel T).
* Space Based Digital Farm Monitoring from space for 2020 dry season farming (CBN Anchor Borrower)

Dr. Shaba has also provided services to several National and International Committees/Panels throughout his tenure as director SSA, amongst are:

* Member, Nigerian Delegation to United Nations Committee on Peaceful Use of Outer Space (UN-COPUOS) from 2005 to date
* Member, Joint Expert Group 8 (JEG8) on the implementation of an integrated AU-EU Joint Strategy under the 8th Partnership on Science, Information Society and Space, 2010 to date.
* Member, Extended Coordinating Team of Global Monitoring of the Environment & Africa (GMES & Africa), 2010 to date
* Executive Committee Member & GEO Principal for Nigeria, Group on Earth Observation (GEO), Geneva, Switzerland (2013-date)

Finally, Dr. Shaba is a member of several organizations and has been conferred with the award of honorary fellow by the following prestigious bodies;

* Geo-information Society of Nigeria (GEOSON)
* Society of Professional Disaster Risk Managers of Nigeria (SOPDRIMN)  Nigerian Cartographic Association (NCA)



**Dr. M. Alkali**

Dr. Muhammad Alkali is a versatile scientist, instructor, and administrator with numerous published articles in academic and scholarly journals. Before he was appointed the Group Head, SIC, Dr Alkali bagged his Ph.D. in Integrated Systems Engineering with a research bias in Spacecraft Power Systems from Kyushu Institute of Technology (KYUTECH/KIT), a prestigious University of Technology in Japan. While in Japan, he participated in the design and development of the Electrical Power System of the Arc Event Generator and Investigator Satellite (AEGIS), a scientific spacecraft also known as Horyu-IV which was successfully launched into orbit on-board the H-2A rocket in February 2016.

He received his Masters degree in Personal, Mobile & Satellite Communications from the University of Bradford, England. His tertiary education commenced with a Bachelor degree (second class- upper division) in Physics/Electronics from the Federal University of Technology Minna, Niger State. Dr. Alkali has had a colourful, impactful career spanning from Advanced Microcomputer Systems to Central Bank of Nigeria (NYSC) to SAGEM SA to the Abuja area office of the United Bank for Africa (UBA) to the National Space Research and Development Agency (NASRDA) and finally to the Nigerian Communications Satellite Limited (NIGCOMSAT) where he has served in various capacities over the years in Satellite Network Control and

Applications. He was also a pivotal member of the AFRICARE-NIGERIA’s project (Independent Policy Group), a think-tank for the President of Nigeria (2002-2003).

Dr. Alkali has always aimed to have an expansive international and local repertoire of knowledge while keeping abreast with industry trends. This has led to his participation in the study visit on European Union Global Navigation Satellite System in Spain, his attendance at the Indian Institute for Public Administration (IIPA) New Delhi, where he trained in Global Strategic Leadership for Growth and Sustainable Development. He attended the Advanced Visioning and Leadership Programme on Managing Human Capital and Shaping Culture organized by TL First Group/Institute of Leadership and Management of UK. He also attended a practical project management course at CCLL, Cardiff University-United Kingdom. He was among the 50 Scientists/Engineers trained at the China Academy of Space Technology/ Beijing Institute of Tracking & Telecommunications Technology for Know-how Technology Transfer training on NigComSat-1 from 2005. In 2008, he attended a Satellite networking course at PT Telkom learning Centre in Bandung, Indonesia.

Dr. Alkali is a fellow of the African Scientific Institute (FASI), a Fellow of the Institute of

Corporate Administration (FCAI), a senior member of the American Institute of Aeronautics and

Astronautics, Member Nigerian Institute of Physics, and a Member of the Computer Professionals Registration Council of Nigeria (MCPN). Dr. Alkali has vast interests ranging from Design thinking; energy; CT; science, technology, and innovations (STI) to spacecraft design and systems integrations (payload and bus systems).



**Professor Abdul Kabir Mohammed**

Professor Abdul Kabir Mohammed is currently serving as Professor and Chair of the Department of Chemistry & Biochemistry at North Carolina Central University, Durham, NC. Previously, he served as the Chair of the Department of Chemistry at Winston Salem State University, WinstonSalem, NC and prior to that appointment he was an Associate Professor at North Carolina A&T State University, Greensboro, NC.

Prof. Mohammed graduated from the University of Benin, Benin-City in 1983 with a B.Sc. (first class honors) degree in chemistry. He worked briefly in 1987 as a Graduate Assistant at Federal University of Technology, Yola (now Modibbo Adama University of Technology), before proceeding to Louisiana State University for his postgraduate education.

He received his Ph.D. in inorganic chemistry in 1982 and did postdoctoral research at Florida State University from 1982 to 1983. He was a Fulbright Scholar at Sultan Qaboos University in Oman from 2003 to 2004; and he served as a Carnegie African Diaspora Fellow at the Federal University of Technology, Minna, Nigeria in the summers of 2017 and 2019. His research interests include photophysics and photochemistry of transition metal complexes and chemical education. He teaches general, inorganic and environmental chemistry courses.



**Prof. Makun Hussaini Anthony**

Prof. Makun Hussaini has 29 years of experience as a university academic staff and a researcher in areas relating to food safety, environmental health monitoring, mycotoxicology and mycology. He possess a Doctorate degree in Biochemistry (Toxicology) after successful completion of a thesis entitled “Studies on mycoflora and mycotoxins contaminating guinea corn and rice in Niger State, Nigeria” This was preceded by an MSc degree in Biochemistry (thesis titled “Analysis of blood levels of trace metals, total lipids and cholesterol in Ajaokuta Steel Industry workers”). The novelty of finding *Fusarium verticillioides* in Nigerian rice during his PhD work, which is the fungi associated with oesophageal cancer (EC) in South Africa, earned him a National Research Foundation Postdoctoral Fellowship (PDF) with Food Environment and Health Research Group of the University of Johannesburg (UJ).

Being a university teaching staff for over almost three decades, Prof. Makun has taught many biochemistry and environmental toxicology related courses at both undergraduate and postgraduate levels. He has supervised and graduated over 85 B-Tech, 18 M-Tech students and 9 PhDs. The graduate students all worked on mycotoxins.

Prof. Makun has won national and international research grants to the cumulative sum of $8, 647,787. 47. He is a Fellow of Mycotoxicology Society of Nigeria (FMSN), a member of the

National Agency for Food and Drug Administration and Control (NAFDAC), National Food

Safety Advisory Committee of Nigeria, National Codex Committee of Nigeria, African Union Expert Committee on Contaminants in Food (2011 to date) and Joint FAO/WHO Expert Committee on Contaminants in Food (JECFA) (2012-2020). He coordinated the writing of the “discussion paper on fungi and mycotoxins in Sorghum” which was adopted as a document of the Joint FAO/WHO Experts Committee on Food Additives (JECFA) in 2012 and participated in the writing of “Proposed draft annex for “prevention and reduction of aflatoxins and ochratoxin A in sorghum” in the existing code of practice for the prevention and reduction of mycotoxin contamination in cereals (CAC/RCP 51-2003)”. He wrote on the prevention and control of sterigmatocystin and diacetoxyscirpenol for the 83rd meeting of JECFA held in November, 2017 in Rome.

Prof. Makun has 72 publications, mostly on mycotoxins in peer review journals, technical papers and books. He was the immediate pass Director of Research, Innovation and Development of the Federal University of Technology Minna, Nigeria. He is currently theLead Researcher of the Food and Toxicology Research Group and Centre Leader of the Africa Centre of Excellence for Mycotoxin and Food Safety of the Federal University of Technology Minna. Project Coordinator of the West African Food Safety Network (WAFOSAN) and Member of the African Food Safety Network. He has served as election monitor, election collation and returning officers at state and national assembly elections from 1999 to 2015). He has passion for jogging and reading. He is married to Barrister Evelyn Pambelo Hussaini and blessed with four children.



## Dr. Eustace Manayi Dogo

Dr Eustace M. Dogo has over ten years of industry experience working in Russia, Europe and

Nigeria. He holds a BSc and MEng degrees in Electrical Engineering from Peter the Great Saint Petersburg Polytechnic University, Saint Petersburg, Russia and PhD degree from the University of Johannesburg, South Africa. His PhD research focused on investigating imbalanced learning using Artificial Intelligence algorithms in real-world drinking-water quality detection problems, where he proposed three new dynamic selection algorithms combined with data pre-processing methods.

Among his notable contributions while at the University of Johannesburg during his postgraduate studies, Dr Eustace Dogo served as a volunteer to the 6th International Conference on Soft Computing and Machine Intelligence (ISCMI 2019) held in Johannesburg, South Africa, on November 19-20. In 2019, he served as a tutor in the first Short Learning Programme (SLP) in Computational Intelligence for Industry, organized by the Institute for Intelligence Systems in collaboration with the Department of Information Systems at the University of Johannesburg, and successfully graduated two batches of students drawn across diverse works of life (over 50 students).

Dr Eustace Dogo was recently among a panel of discussants in the University of

Johannesburg’s *Cloudebate* on the Fourth Industrial Revolution and Technology for People with Disabilities. Between 2018 and 2019, he co-supervised to completion 16 undergraduate students in the Department of Electrical and Electronic Engineering Science, University of Johannesburg, South Africa. He also presented a technical talk at the *POWER-GEN & DistribuTECH - GEN-X* conference and exhibition which took place in Sandton, Johannesburg in 2017.

Dr Eustace Dogo has extensive knowledge in industry, research, training and teaching. He is an active undergraduate and postgraduate degree supervisor and has authored and co-authored in reputable journals, conferences and several scholarly research books in his areas of interest. He joined the academia in 2012 and currently lectures at the Department of Computer Engineering, Federal University of Technology Minna, Nigeria. His broad research interest includes, theoretical and applied Machine Learning, Intelligent Systems, Cloud Computing and Emerging Technologies. He is married to Barrister Fatima Eustace-Dogo and blessed with three children.

## CONFERENCE WORKSHOP FACILITATOR



**Prof. Derek Tantoh Ndinteh**

Prof. Derek Tantoh Ndinteh is an expert in areas of Natural Products Chemistry; drug discovery and drug delivery platforms. He is currently working on Natural Products Chemistry that deals with extraction, purification, isolation and characterization of chemical substances and evaluation of biological and pharmacological activities of African plants for pharmaceutical industries.

He is interested in collaborating with Federal University of Technology, Minna on the evaluation of the antidiabetic, antimicrobial, antioxidant, anticancer and anti-ulcerogenic potentials of secondary metabolites from Nigerian Medicinal Plants.

Our interaction so far with Prof. Derek Tantoh Ndinteh has been very mutual and beneficial to both Universities involved because it has potential to increase our visibility at global level based on academic activities and mainstreaming and replication of the research and teaching outcomes of this collaboration by the staff and students can be integrated into overall development of Nigeria and South Africa.

**CHEMICAL/LIFE SCIENCE**

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**Antibacterial Activity and FTIR Characterization of subfractions fromEthylacetate**

**Fraction of *Piliostigma thonningii* against some *Salmonella species***

1Abdulsalami Halimat, 2Mudi Suleiman Yusuf, 1Daudu Oladipupo Abdulazeez Yusuf, 3 Adabara Nasiru Usman, 4Hamza Rabiat Unekwu and 5Abdulsalam Sa’adatu 1,3,4Department of Plant Biology, Federal University of Technology, Minna, Nigeria.

2Department of Pure and Industrial Chemistry, Bayero University, Kano, Nigeria.

5Department of Chemistry, Confluence University of Science and Technology Osara, Kogi State. \* E-mail of the corresponding author: halimat.abdul@futminna.edu.ng

**ABSTRACT**

*The present study deals with the antibacterial activity and functional group analysis of Piliostigma thonningii extract, its fractions, sub-fractions and column isolates. The crude methanol extract of the plant (PT1), its partitioned-soluble fractions (PT1-01, PT1-02, PT1-03 and PT1-04), sub-fractions from VLC fractionation of ethyl acetate fraction (VLC1 –VLC7) and column sub-fractions (Et1-Et6) were screened for their antibacterial potentials using agar well diffusion technique. The crude methanol leaf extract was first partitioned with different organic solvents to afford the n-hexane- chloroform- and ethyl acetate-partitioned-soluble fractions. The antibacterial active ethyl acetate – partitioned soluble fraction was further fractionated over a vacuum liquid chromatography followed by column chromatography of the antibacterial active VLC sub-fraction (VLC5). Characterization of the antibacterial active column subfractions was done using Fourier transform infrared spectroscopy (FTIR). The results showed that all the fractions possess antibacterial activity on at least one of the bacteria tested, however, the ethyl acetate fraction (PT1-03) exhibited the widest zone of inhibition on the test bacteria (14-16mm) at the concentration of 100mg/ml. The zones of growth inhibition increased with increasing concentration of the extracts. The corresponding increase in concentration and growth inhibition zone was significant (p<0.05). The FT-IR result of the column isolate from the ethylacetate fraction revealed the presence of phenols, aldehydes, ketones, amines, amides and carboxylic acids. The spectra of the activity exhibited by the isolates signified their potency for the development of therapeutic agents against these pathogenic bacteria.*

**Keywords**: Antibacterial activity, Column chromatography, Growth inhibition, Solvent partitioning, Spectrophotometer.

1. **Introduction**

The use of plants and its products has a long history that began with folk medicine and since then remarkable progress has been made in the field of medicine with the discoveries of many natural and synthetic drugs (Preethi *et al.,* 2010).Antibiotics are undeniably one of the most important therapeutic discoveries of the 20th century that had effectiveness against serious bacterial infections. However, only one third of the infectious diseases known have been treated with these synthetic products (Sharma, 2011). This is because of the emergence of resistant pathogens that are beyond doubt the consequence of years of widespread indiscriminate use, incessant and misuse of antibiotics. Antibiotic resistance has increased substantially in the recent years and is posing an ever increasing therapeutic problem (Anyanwu and Okoye, 2017). In nature, plants are bestowed with chemical compounds to help provide defense against predators. It is expected that plant extracts showing target sites other than those used by antibiotics will be active against drug resistant pathogens (Sen and Batra, 2012). Some of the secondary metabolites in plants have also been identified to act as drug precursors which may be utilized for the production of the more potent synthetic drugs. Plants natural products chemistry have played an active role in generating a significant number of candidate compounds in drug discovery programs (Pillai and Nair, 2014).

However, the climate and other ecological conditions may affect production of secondary metabolite in medicinal plants and need to be incessantly monitored to maintain the potency of the plant drugs (Chandrika *et al.,* 2013). Fingerprinting (marker compound analysis) by chemical and validated chromatographic and spectroscopic techniques are gaining importance for standardization in the herbal medicinal formulations. The evaluation of a herbal product by metabolomic fingerprinting can be accomplished by appropriate methods, including High performance liquid chromatography (HPLC) with Ultraviolet diode array detector(UV DAD), Evaporative light scattering detector (ELSD), Gas chromatography mass spectrometry (GC-MS), High performance thin layer chromatography (HPTLC), Fourier transform infrared spectroscopy (FT-IR), Near infrared (NIR), Nuclear magnetic resonance spectroscopy (NMR) or a combination of these techniques. Such techniques also provide useful information about qualitative and quantitative composition of herbal medicines and their pattern recognition by chemometry (Geethu *et al.,* 2014). The Fourier transform infrared (FTIR) spectroscopy has proven to be a valuable tool for the characterization and identification of compounds or functional groups (chemical bonds) present in an unknown mixture of plant extracts (Maobe and Nyarango, 2013). The FTIR measures predominantly the vibrations of bonds within chemical functional groups and generates a spectrum that can be regarded as a biochemical or metabolic “fingerprint” of the sample (Mariswamy *et al*., 2012). The present study therefore, evaluates the antibacterial activity, as well as; the presence or absence of various functional groups in the crude methanol leaf extract of *P. thonnigii* and its fractions using FTIR.

1. **Materials and Methods**
	1. **Collection and Identification of the plant**

Matured leaves of *P. thonningii* were collected along Gidan kwano Road Minna, Niger State, Nigeria. The plant was identified at the herbarium unit of the Department of Biological Sciences, Ahmadu Bello University, Zaria where voucher number 171 was deposited.

* 1. **Plant Preparation**

The leaves were carefully washed under running water, air‐dried at room temperature and then milled into fine powder. About 300 g of the powdered leaves of the plant was macerated with 1.5 liters of 70% methanol for 72 hours. The resulting mixture was filtered using a muslin cloth and subsequently concentrated using a rotary evaporator. The extract was weighed, placed in sterile sample bottles and stored in a refrigerator until required for use (Tiwari *et al*. 2011).

* 1. **Solvent partitioning of crude extract**

The methanol crude extract (40g) was subjected to solvent‐solvent partitioning by using the methods employed by Emran *et al*. (2015). The crude extract was successively partitioned by using solvents of increasing polarity in the following order; n‐hexane, chloroform and ethyl acetate in a separating funnel. The resulting fractions of the crude extract were evaporated to dryness using rotary evaporator at 40℃ to afford fractions labelled as the hexane (PT1-01), chloroform (PT1-02), ethyl acetate (PT1-03) and methanol (PT1-04) soluble fractions. All the fractions were weighed and stored in air tight containers till further analysis.

* + 1. **Reconstitution of Plant extract and Fractions**

Using an analytical weighing balance one gram (1 g) of extract and each fraction were dissolved in 5 ml of 50% dimethylsulphoxide (DMSO) to make 200 mg/ml stock solution from which was serially diluted to give concentrations of 100 mg/ml, 50 mg/ml and 25 mg/ml.

* 1. **Vacuum Liquid Chromatography (VLC) and Column Chromatography of Ethyl acetate Fraction of *P. thonningii***

The most antibacterial active partitioned fraction (Ethylacetate fraction of *P. thonningii*, PT1-03) was further exploited in an attempt to isolate the active principle which exhibited the antibacterial activity. The method described by Amin *et al*., (2012) was adopted for the isolation procedure. The ethyl acetate extract was further fractionated using VLC to afford VLC sub-fractions, coded VLC1VLC7. The most active VLC sub-fraction (VLC5) which exhibited significant activity against the test organisms were subjected to column chromatography using the method described by Dauda and Mudi (2013) with slight modification. About 250 g of silica gel (60-120 mesh size) was made into slurry of n-hexane and packed by wet method into a glass column (3.8 cm by 53 cm) in slurry of n- hexane. The sub-fraction (2g) was dissolved in methanol and then mixed with a small quantity of silica gel, dried, triturated and then loaded on top of the column already packed with silica gel. Sequential elution was carried out using stepwise gradient solvents of increasing polarity in the following order: n-hexane (100%), n-hexane - chloroform (1:1), chloroform (100%), chloroform- ethyl acetate (4:1), chloroform-ethyl acetate (1:1), chloroform-ethyl acetate (1:2), chloroform-ethyl acetate (1:4), ethyl acetate (100%), ethyl acetate-methanol (9:1), ethyl acetate-methanol (4:1), ethyl acetate-methanol (1:1), methanol (100%), methanol-water (1:1) and 100% water. The process was monitored using the thin layer chromatography. An aliquot of 20 ml of the eluates were continuously collected into test tubes from the beginning to the end of the elution, in each case the eluates having similar TLC profile were pooled together into major sub fractions which were further subjected to antibacterial activity.

* 1. **Characterization of Column sub-fractions**

The semi-purified sub-fractions that displayed significant antibacterial activity were identified using FTIR. The infrared spectra of the column isolates were recorded on Agilent Technologies model FTIR 4100 excoscan at the Ahmadu Bello University (ABU) Zaria, Kaduna State. The spectra were scanned in the 650 to 4000 cm-1 range. The spectra were obtained using transmittance method and were plotted as intensity versuswave number. The functional groups (obtained by FTIR analysis) present in each of the active column isolate was interpreted with the aid of structure correlation chart (Oyerinde and Bello, 2016).

* 1. **Antibacterial assay**
		1. **Test organisms**

Clinical isolates of *Salmonella typhi, Salmonella paratyphi* A*, Salmonella paratyphi* B and *Salmonella paratyphi C* were obtained from the Microbiological laboratory of Aminu Kano teaching Hospital, Kano for the susceptibility tests. The organisms were used after their identity were confirmed at the Department of Microbiology, Bayero University, Kano. The stock culture was maintained on Nutrient agar slant at 4℃ in the refrigerator.

* + 1. **Antibacterial Susceptibility Test**

The sensitivity of extract, fractions and sub-fraction was determined using the agar well diffusion method as described by Nas and Ali (2017) with modifications. With the aid of a sterile cotton swab the prepared bacterial suspension equivalent to 0.5 McFarland Standard (1.5 x 106 CFU) was inoculated onto sterile Mueller- Hinton agar plates. A sterile 6 mm diameter cork borer was used to bore 3 wells into the agar plates. The wells were then filled up with approximately 0.1ml of the extract solution at a concentration of 25, 50 and100 mg/ml taking care to prevent spillage onto the surface of the agar medium. The plates were allowed to stand on the laboratory bench for 1 hour to allow proper diffusion of the extract into the medium after which the plates were incubated at 37 ℃ for 24 hours, and thereafter the plates were observed for zones of inhibition and measured.

* 1. **Statistical Analyses**

The statistical analyses were carried out using statistical package for social sciences (SPSS‐ computer package). Data from the antibacterial activities of *P. thonningii* were expressed as mean

± standard error of three independent replicates and also subjected to one‐way analysis of variance (ANOVA) at p<0.05 level of significance for comparison of the extract activities.

**3.0 Results and Discussion**

Plant extracts are considered to be valuable source of biological active compounds. In this study the antibacterial activity of the crude extract, fraction and fractions of *P. thonningii* were assessed against some *Salmonella species*. The crude extract andall the other fractions had good antibacterial activity against all the tested organisms except n-hexane soluble fraction (Table 3.1). This could be that the bioactive compounds present in the plant were more soluble in polar solvents as compared to the non‐polar solvents. However the most active fraction was ethylacetate soluble fraction as it showed the largest zone of bacterial inhibition (11-16 mm) as such was subjected to vacuum liquid chromatography. The antibacterial activity of all the seven sub-fractions obtained from vacuum liquid chromatography of *P. thonningii* ethylacetate fractionis shown in Table 3.2. All the sub-fractions except sub-fraction seven (VLC7) showed zones of inhibition on at least one organism. However sub-fraction five (VLC5) was the most active against the bacteria strains tested, as a result of which it was further purified using column chromatography. Table 3.3 show the results of antibacterial activity of sub-fractions obtained from column chromatography of sub-fraction VLC5. The bacterial strains tested were susceptible to column sub-fraction Et1 and Et2. However Et1 indicated the strongest antibacterial activity on the test organisms at low concentration of 50 mg/ml (11-15 mm) when compared with the crude extract and previous fractions. Column subfractions Et3-Et6 exhibited no zone of inhibition. The present study has shown that antibacterial activity varies with fraction. The observed difference could be attributed to the variation in the distribution of active principles according to their affinity for the solvent used in fractionation. Few investigations on the antibacterial properties of *P. thonningii* have been reported. Chukwunonye *et al.,* (2017) had also reported the potency of the leaf extract and fractions of *P. thonningii* on *S. typhi* and other bacteria.

**Table 3.1: Zones of growth inhibition (mm) of the crude extract and fractions of the leaves of *P. thonningii* on the test bacteria**

|  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- |
| Crude/ Fractions  | Conc. (mg/ml)  | *S. typhi*  | *S. paratyphi A*  | *S. paratyphi B*  | *S. paratyphi C*  |
| PT1  | 25  | 10± 0.33c  |  0± 0.00c  | 09± 0.00c  |  0± 0.00c  |
|   | 50  | 12± 0.58b  | 09± 0.33b  | 11± 0.33b  | 09± 0.33b  |
|   | 100  | 15± 0.33a  | 12± 0.58a  | 15± 0.33a  | 11± 0.33a  |
| PT1-01  | 25  |  0± 0.00a |  0± 0.00a |  0± 0.00a |  0± 0.00a |
|   | 50  |  0± 0.00a |  0± 0.00a |  0± 0.00a |  0± 0.00a |
|   | 100  |  0± 0.00a |  0± 0.00a |  0± 0.00a |  0± 0.00a |
| PT1-02  | 25  |  0± 0.00b |  0± 0.00b |  0± 0.00c  |  0± 0.00c  |
|   | 50  |  0± 0.00b |  0± 0.00b | 11± 0.58b  | 12± 0.33b  |
|   | 100  | 12± 0.33a  |  8± 0.33a  | 13± 0.33a  | 14± 0.00a  |
| PT1-03  | 25  | 11± 0.33c  |  0± 0.00c  | 13± 0.33c  | 12± 0.33c  |
|   | 50  | 12± 0.33b  | 12± 0.00b  | 14± 0.33b  | 13± 0.58b  |
|   | 100  | 14± 0.33a  | 15± 0.33a  | 16± 0.33a  | 15± 0.88a  |
| PT1-04  | 25  |  0± 0.00c  |  0± 0.00c  |  0± 0.00c  |  0± 0.00c  |
|   | 50  | 11± 0.33b  |  9± 0.33b  |  9± 0.33b  |  9± 0.33b  |
|   | 100  | 10± 0.33a  | 12± 0.33a  | 12± 0.33a  | 11± 0.33a  |

Values are presented in means ± Standard error of three replicates.

Values with the same superscript on the same column are not significantly different at P>0.05.

Keys: PT1- Methanol extract; PT1-01- n-hexane soluble fraction; PT1-02-Chloroform soluble fraction; PT1-03- Ethylacetate soluble fraction; PT1-04- Aqueous methanol soluble fraction **Table 3.2: Antibacterial activity of VLC sub-fractions obtained from Ethylacetate fraction of *P. thonningii***

|  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- |
| Sub-fractions  | Conc. (mg/ml)  | *S. typhi*  | *S. paratyphi A*  | *S. paratyphi B*  | *S. paratyphi C*  |
| VLC1  | 50  | 11  | 10  | 11  | 11  |
|   | 100  | 12  | 11  | 11  | 12  |
| VLC 2  | 50  | 10  | 8  | -  | 8  |
|   | 100  | 11  | 10  | 9  | 8  |
| VLC 3  | 50  | 8  | -  | 8  | -  |
|   | 100  | 8  | 8  | 9  | 8  |
| VLC 4  | 50  | 8  | 8  | -  | -  |
|   | 100  | 8  | 9  | -  | -  |
| VLC 5  | 50  | 13  | 8  | 12  | 11  |
|   | 100  | 13  | 9  | 12  | 11  |
| VLC 6  | 50  | -  | -  | -  | -  |
|   | 100  | 9  | -  | -  | -  |
| VLC 7  | 50  | -  | -  | -  | -  |
|   | 100  | -  | -  | -  | -  |

Key: - No zone of inhibition

**Table 3.3: Antibacterial activity of isolates obtained from Column Chromatography (Et1-Et6) of *P. thonningii***

|  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- |
| Fractions  | Conc. (mg/ml)  | *S. typhi*  | *S. paratyphi A*  | *S. paratyphi B*  | *S. paratyphi C*  |
| Et 1  | 25  | 13  | 14  | 12  | 13  |
|   | 50  | 15  | 15  | 13  | 15  |
| Et 2  | 25  | 11  | -  | 11  | -  |
|   | 50  | 11  | -  | 11  | 11  |
| Et 3  | 25  | -  | -  | -  | -  |
|   | 50  | -  | -  | -  | -  |
| Et 4  | 25  | -  | -  | -  | -  |
|   | 50  | -  | -  | -  | -  |
| Et 5  | 25  | -  | -  | -  | -  |
|   | 50  | -  | -  | -  | -  |
| Et 6  | 25  | -  | -  | -  | -  |
|   | 50  | -  | -  | -  | -  |

Key: - No zone of inhibition

Infra-Red spectroscopy is basically a vibrational spectrum and involves the measurement of wavelength and intensity of absorption of mid infrared light by a sample. The FTIR result for the column isolate Et1 showed that a characteristic absorption bands were exhibited at 2922.2 cm-1, 2855.1 cm-1 for C-H stretching and 1692.2 cm-1, 1640.0 cm-1 for C=C bending (Table 3.4) (Figure

1). The column isolate Et2 showed the characteristic absorption bands at 2926.0 cm-1, 2855.1 cm1 for C-H stretching and 1640.0 cm-1 for C=C bending (Table 3.5) (Figure 2). The present FT-IR results confirmed the presence of phenols, alkanes, aldehydes, ketones, amines, amides, alkenes, carboxylic acids, and alcohols in the column isolates. Phenols are of great importance as they protect the human body from the oxidative stress, which cause many diseases including cancer, cardiovascular problems and ageing. They exhibit antimicrobial, anthelmintic, antiapoptotic and antidiarrhoeal activities (Cowan,1999). Amines and amides are the main groups of protein synthesis. Carboxylic acids are biologically very important in the formation of fat in the body and act as strong antibacterial agents (Pillai and Nair, 2014).

Figure 1: FTIR spectra of Column isolate Et1 Figure 2: FTIR spectra of Column isolate Et2

### Table 3.4: FTIR Interpretation of Column isolate Et1

 **Wave number (cm-1)** **Types of vibration** **Functional groups**

 3384.4 N-H stretch/ O – H Amino group, hydroxyl group

 2922.2, 2855.1 Asymmetrical stretching C-H (alkanes)

 1692.2,1640.0 Stretching C=O (ester carbonyl functional group

 1379.1, 1457.4 Bending and rocking C – H (methyl or –CH3)

 1036.2- 1248.7 Stretching C-N, C-O Aliphatic amines/alcohols,

carboxylic acids

 708.2- 972.8 Out of plane bending Aromatic C-H bending

### Table 3.5: FTIR Interpretation of Column isolate Et2

**Wave number (cm-1)** **Types of vibration** **Functional groups**

3384.4 N-H stretch/ O – H Amino group, hydroxyl group

2926.0, 2855.1 Asymmetrical stretching C-H (alkanes)

1513.3-1699.7 Stretching C=O (ester carbonyl functional group

1379.1, 1436.6 Bending and rocking C – H (methyl or –CH3)

1077.2- 1218.8 Stretching C-N, C-O Aliphatic amines/alcohols,

carboxylic acids

685.8- 888.5 Out of plane bending Aromatic C-H bending

1. **Conclusion**

The antibacterial activity of the leaves of *P. thonningii* showed that the crude extract, fractions and sub-fractions demonstrated antibacterial effect against the test organisms with higher activity in the column isolates when compared to the other fractions. The antibacterial activity of the plant parts can be attributed to the presence of some phytochemicals identified in this study. The ethyl acetate fraction of the plant extract and identified chemical isolates may therefore be a readily available source of cheap and potent antibacterial agents to be used in the therapy of infections caused by these often multi resistant organisms. These findings provided a rationale for the ethnomedicinal use of the plant in traditional medicine.

1. **Acknowledgement**

This study was part of a research project funded by the TETFUND Institution based research intervention (IBRI) Fund (TETFUND/FUTMINNA/2016-2017/6th BRP/18) Federal University of Technology Minna, Niger State, Nigeria.

**References**

Amin, N., Qadir, M.I., Khan, T.J., Abbas, G., Ahmad, B., Janbaz, K.H. & Ali, M. (2012). Antibacterial activity of vacuum liquid chromatography (VLC) isolated fractions of chloroform extracts of seeds of *Achyranthes aspera*. *Journal Chemical Society of Pakistan,* 34(3):589-592

Anyanwu, M.U. & Okoye, R.C. (2017). Antimicrobial properties of Nigerian plants. *Journal of Intercultural Ethnopharmacology,* 6 (2): 240-259

Chandrika, R., Komal, K.J., Thara, S.K.J., & Deviprasad, A.G. (2013). FTIR spectroscopic studies and antimicrobial activity in populations of *Eryngium foetidum* L. *International Journal of Pharmacy*, 3(4):813-818.

Chukwunonye, U.C.E., Ebele, O.P., Kenne, T.M. & Gaza, A.S.P. (2017). Phytochemical screening and antimicrobial activity of methanol extract and fractions of the leaf of *Piliostigma thonningii* Schum (Caesalpiniaceae). *World Applied Sciences Journal 35* (4): 621-625 Cowan, M. M. (1999). Plant products as antimicrobial agents. *Clinical Microbiology Reviews*, 12 (4): 564–582.

Dauda, U. & Mudi, S.Y. (2013). Screening and bioassay-guided isolation of antimicrobial components from *Laggera mollis. Bayero Journal of Pure and Applied Sciences,*6(1):152

– 158.

Emran, T., Rahman A, Nasiruddin, M.N., Rahman, M., Uddin, Z., Dash, R & Layzu C. (2015). Effects of organic extracts and their different fractions of five Bangladeshi plants on *in vitro* thrombolysis. *BMC Complementary and Alternative Medicine,* 15, 128‐135.

Geethu, M. G, Suchithra, P. S., Kavitha, C. H., Aswathy, J. M., Babu, D. A & Murugan, K. (2014). Fourier-transformation infrared spectroscopy analysis of different solvent extracts of Water hyacinth (*Eichhornia crassipes* mart solms.) an allelopathic approach*. World Journal of Pharmacy and Pharmaceutical Sciences,* 3 (6): 1256-1266.

Maobe, M. A. G. & Nyarango, R. M. (2013). Fourier transformation infra-red spectrophotometer analysis of *Warburgia ugandensis* medicinal herb used for the treatment of diabetes, malaria and pneumonia in Kisii Region, Southwest Kenya. *Global Journal of Pharmacology,* 7 (1): 61-68.

Mariswamy, Y., Gnanaraj, W. E. & Johnson, M. (2012). FTIR Spectroscopic studies on *Aerva lanata* (l.) Juss. ex schult. *Asian Journal of Pharmaceutical and Clinical Research*, 5 (2): 82-86.

Nas, F. S. & Ali, M. (2017). Antibacterial activity of *Boswellia dalzielii* leaves extracts against some pathogenic bacterial isolates. *Journal of Advances in Microbiology* 7(1): 1-8.

Oyerinde, A.Y. & Bello, E. I. (2016). Use of Fourier transformation infrared (FTIR) spectroscopy for analysis of functional groups in Peanut oil biodiesel and its blends. *British Journal of Applied Science & Technology,* 13(3): 1-14.

Pillai, L.S. & Nair, B.R. (2014). Functional group analysis of *Cleome viscosa* L. and *C. burmanni* W.&A. (Cleomaceae) extracts by FT-IR. *Journal of Pharmacognosy and Phytochemistry,* 2(6): 120-124.

Preethi, R., Devanathan, V.V. & Loganathan, M. (2010). Antimicrobial and antioxidant efficacy of some medicinal plants against food borne pathogens. *Advances in Biological Research* 4(2): 122-125.

Sen, A & Batra, A. (2012). Evaluation of antimicrobial activity of different solvent extracts of Medicinal plant: M*elia azedarach L*. *International Journal of Current Pharmaceutical Research*,4(2):67-73.

Sharma, A. (2011). Antibacterial activity of ethanolic extracts of some arid zone plants*. International Journal of PharmTech Research*, 3(1):283-286.

Tiwari, P., Kumar, B., Kaur, M., Kaur, G., and Kaur, H. (2011). Phytochemical screening and extraction: A review. *Internationale Pharmaceutica Sciencia,* 1(1): 98-106.