

MY FULBRIGHT RESEARCH AT RUTGERS UNIVERSITY: A LIFETIME EXPERIENCE

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ABSTRACT

I was a Fulbright Visiting Scholar in 2021 at Rutgers University in New Jersey. My research was aimed at isolating hydrocarbon-degrading bacteria from contaminated soil samples. I was able to isolate bacterial species that have the ability to degrade a variety of aromatic hydrocarbons and sequence some of them. This research contributes to the existing database on hydrocarbon-degrading bacteria. It also will influence policy changes in the field of environmental microbiology.

Keywords: Microbiology • bacteria • Rutgers University • Fulbright Visiting Scholar program • biotechnology



REFOCUSING APPLICATION OF MICROBIAL SCIENCES IN THE REAL WORLD

Through my years practicing microbiology in research and also in teaching, there has always been that yearning to apply my specific area of research in the field. Applying for the Fulbright scholar program was top on my to-do list following the completion of my Ph.D. research in 2016. I had senior colleagues that were Fulbright Scholars and the impact of the fellowship on their career was evident. Three qualities that stood out in both of them were: an eagerness to mentor younger colleagues in research, ability to discern relevant research topics and exceptionally good skills in networking. This further strengthened my decision to also be a part of such an obviously laudable program. On conducting some research online, I realized the Fulbright program was even more prestigious than I imagined. I applied for the Fulbright Visiting Scholar program for the first time in the year 2018/2019. I got to the interview stage but wasn't selected at the final phase. Undeterred, I applied in the following year, 2019/2020 and this time I made the final cut. I was ecstatic with joy because deep inside me I knew it would mark an important turning point in my career as an academic. As a result of the COVID-19 pandemic, I couldn't make the trip to the United States in 2020, and prepared to arrive in the US in January 2021.

SETTLING DOWN IN THE GARDEN STATE

I made my trip to the US in late January in the midst of the pandemic arriving in the cold winter at Newark International airport in the state of New Jersey. My host professor was frequently in touch with me and after I had secured accommodation close to the university campus (Cook Campus), I met briefly with Dr. Gerben J. Zylstra for the first time. He introduced me to the doctoral candidates in his lab, and also took me on a short tour of the facilities. Due to the pandemic, and the COVID protocol, there were a set of lab rules to ensure social distancing was maintained in our time in the laboratory. I was shown to the portion of the lab where I would be conducting my research and also given a copy of the lab key and shown to a personal office I would use during my time there. I was able to secure a flash card from the Information Technology (IT) department in the university so that I could gain access to the building and its facilities. Then, work started in earnest.

LABORATORY STUDIES

My host faculty was Dr. Gerben J. Zylstra, a Distinguished Professor and Director of the Graduate Biology program, Department of Biochemistry and Microbiology, School of Environmental and Biological Sciences. He has been nothing short of amazing all through our correspondence before my arrival in the US. I had read and cited his papers during my doctoral research years ago, so he was my first point of call when I needed a host professor. We share similar research interests in the field of biodegradation of harmful compounds, and I feel so lucky to have been hosted by him. The focus of my research at Rutgers University was on studying bacteria in soil with the potential to break down hydrocarbons commonly found in certain industrial activities (petroleum industry, coal processing plants).

As an environmental microbiologist, I am interested in harnessing the potential of microorganisms for the benefit of other living beings and the environment. Essentially, the ability of bacteria isolated from petroleum-contaminated soils in oil-producing regions in Nigeria were assessed in the laboratory for their ability to utilize six different hydrocarbons for their growth requirements. Following isolation of the bacteria on microbiological growth media in the laboratory, the prominent and fast-growing colonies were preserved for further studies. Subsequently, they were tested in several rounds of experiments for their ability to use selected hydrocarbons for their metabolic needs. These compounds include the mono-aromatic hydrocarbons (m-xylene, o-xylene, and ethylbenzene) and polycyclic aromatic hydrocarbons (naphthalene, dibenzofuran, and biphenyl).

The bacteria were identified using tools that enabled us to determine their lineage based on the information in their DNA. This was achieved by amplifying the 16S ribosomal ribonucleic acid (16S rRNA) gene by polymerase chain reaction (PCR), and then subsequently determining their nucleotide sequence by Sanger sequencing. Subsequently their identity (the genus and

species based on taxonomy) was inferred based on the closest matches obtained when comparing their nucleotide sequences with those on the database of the National Center for Biotechnology Information (NCBI). The entire genome sequence of selected species of bacteria was determined by Next Generation Sequencing (NGS). These species were selected based on their high efficacy in degrading the hydrocarbons. This method reveals the complete profile of the bacteria with regards to their metabolic capabilities and other functions. Interestingly, we discovered that some of the bacteria had the ability to breakdown two or three of the compounds. The implication of this is the potential of these microorganisms to be used in field applications to clean up similar compounds polluting aquatic and terrestrial ecosystems. Also worthy of mention is the fact that many field studies in Nigeria do not focus on identifying these hydrocarbon-degrading bacteria using next generation sequencing. Hence certain vital information about these organisms could be overlooked. A big factor impeding this aspect of research in Nigeria is the paucity of funds. Thus, researchers in this area often rely on external funding bodies or collaborations with peers in foreign countries.

Another important outcome of our research was the discovery of species that are not frequently encountered in these studies. It was interesting to note that even though my principal investigator (PI) and I had similar research interests, there were some differences in the way we conducted certain routine laboratory procedures. Even though this may not have any bearing on the overall outcome of the experiments, it certainly accounts for differences in the turnaround time of an experiment. Nevertheless, there were several fundamental procedures which were likely to have significant impact in the final result especially in the stage of isolating the bacteria from the soil sample. The procedure used in my host lab involved some intricate details as opposed to the relatively simpler technique I am accustomed to in my home institution. This is probably because the relevant equipment to achieve this level of detail is not available in my institution.

Of particular interest to me is the documentation that surrounds handling the hydrocarbons in the laboratory, especially before their disposal at the end of the experiments. I found this to be important since many institutions in my home country lack the training on how to handle, store and dispose of these chemicals. Perhaps policies guiding this procedure need to be created and relevant training provided for academics, technologists and students handling these chemicals. The Biosafety/Blood pathogens and Laboratory Safety refresher courses are an annual requirement for those of us working in the laboratory at the Department of Biochemistry and Microbiology at Rutgers University. In 2021, we took the course online due to the pandemic. These courses certainly provided enlightenment on the importance of proper handling and disposal of laboratory chemicals and reagents after use. This is a key to ensuring that harmful compounds do not find their way into the environment.

The application of bacteria and fungi in removing harmful pollutants from contaminated terrestrial and aquatic environments is not a new technology. However, it has not been fully explored in my home country of Nigeria. In the petroleum industry, soils contaminated with hydrocarbons in the upstream sector usually undergo remediation using physical and chemical methods, and recently with the use of certain plants. However, remediation and reclamation of hydrocarbon-contaminated lands using microorganisms (bioremediation) is not a common practice except in laboratory experiments. The result of widespread petroleum spillage in oil producing regions in Nigeria has negatively affected the local community as their health and source of livelihood

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become compromised. It is thus necessary to fully understand the nature of bacteria dwelling in contaminated soils and determine their ability to utilize these hydrocarbons, in order to possibly apply them in cleaning up large areas of oil spillage. Bioremediation offers a more reliable means of restoring polluted environments due to its cost effectiveness and eco-friendly mode of action which ensures little or no adverse effect to the environment. The outcome of my research has led to isolation of bacteria which

I plan to apply in oil spillage sites in Nigeria as a green solution and sustainable means of restoring the environment.

My stay at Rutgers exposed me to new technologies which I had not been able to utilize in the past, in particular, next generation sequencing techniques. It's a technology that we are utilizing to analyze the genes enabling the proficient bacteria I isolated in the lab to degrade hydrocarbons. This provides the basis for comparisons with other bacterial species with similar functions. A substantial aspect of this technique is conducted as a "dry lab" procedure thus, relying on relevant data analysis and computational tools. This will eventually lead to the publication of articles in high quality journals with wide readership thus improving the web visibility of my profile and that of my home institution. I was also able to learn how to utilize conventional methods in new ways (using multiple laboratory culture media to increase the chances of isolating bacteria) to enhance the study of the activities of beneficial bacteria.

My Fulbright Scholar experience at Rutgers University has enabled me to teach my students, especially my graduate students, new methods I have learned and how to apply them during laboratory analyses. This is already in place, and currently one of my Ph.D. candidates is using these methods to achieve faster results in the laboratory.

75 IS A DOUBLE BLESSING!

A wonderful coincidence with the 75th anniversary of the Fulbright program is that my mother also turned 75 in 2021. I couldn't help but see this as a special twist of fate. My mother holds a special place in my heart because I lost my dad at a very young age and my mother was responsible for single handedly raising my siblings and me. She taught me the value of hard work, and never being afraid to have big dreams. My mother turned 75 on February 13, 2021; and even though I couldn't celebrate with her on her big day because I was far away in the US, I was glad that I was literally living the life she groomed for me. I am deeply honored to have experienced my Fulbright fellowship on a special year in my mother's life.

ENRICHING EXPERIENCE

By the end of my fellowship stay, I loved getting to know and understand the intricacies of the State of New Jersey. I realized that practically every state in the United States is unique in its own way, particularly in terms of certain traffic regulations and the academic calendar for grade school. It was interesting to note the rich ethnic diversity in the city of New Brunswick where I lived for most of my fellowship. I met people from virtually all parts of the world: Egypt, Iraq, India, Mexico, Macedonia and so many other countries. It was interesting meeting other Fulbrighters through the online events hosted by One to World, and some of them eventually became close friends with whom I still maintain contact even after returning to Nigeria. Even though we had limited in-person events, the virtual events made a strong social impact in fostering friendships. It was an absolute thrill getting to learn about other cultures especially in terms of cuisine and recreational activities, as well as sharing aspects of our research and academic careers. I met people that were so helpful and warm to a stranger with an African accent. I have found new ways of elevating the learning experience for my students, and also how to apply new methods in my research particularly with my graduate students. My network is bigger because I had the rare opportunity of meeting many notable personalities in academia and the industry through the virtual meetings I attended, and there is the possibility of fostering collaborations in the near future.

A particularly helpful feature within the Fulbright community is the creation of smaller circles within the larger network based on location of the scholars (those within proximal distance). In my case, I was able to affiliate and socialize with other New Jersey and New York Fulbright Scholars. At one such meeting, I met a Fulbrighter named Servena. She was the recipient of a Fulbright Teacher's award in the preceding year, and happened to reside in a nearby city in New Jersey. We became close friends and she invited me to spend the last few weeks of my fellowship with her which I happily accepted. She took me on a tour of New York city and also on a visit to the beach. And

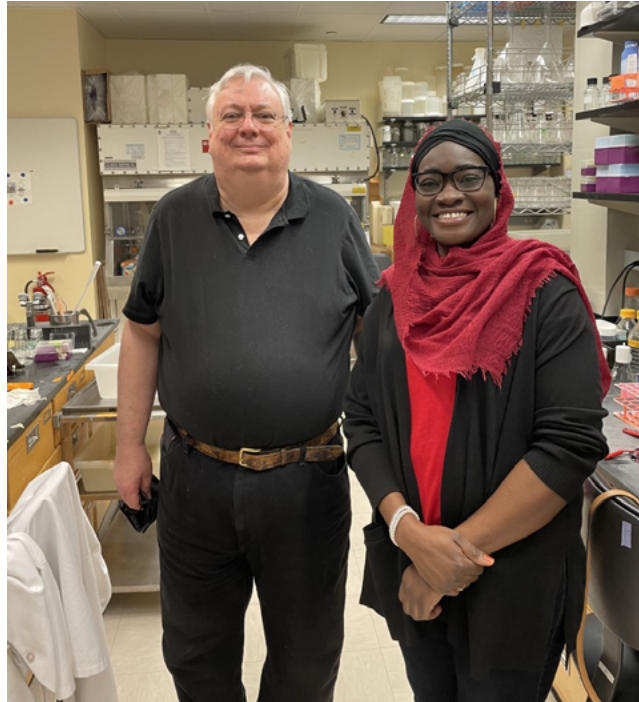
because she was a teacher in New York city, I became involved in a project with her students that allowed me to share part of my culture in relation to Nigerian cuisine, dance and music, traditional clothing. It was a fun experience but also a learning moment for me as well, as I also got to learn about the culture and traditions of other invited speakers from other parts of the world. She made my last few weeks in the States very pleasant and exciting and I will be forever grateful to her.

There is a possibility for future collaborations with Dr. Zylstra as we have discussed the likelihood of having my graduate students conduct their research in his laboratory if the need arises. We frequently discussed how graduate programs are run in the US and in Nigeria, and there are some similarities as well as marked differences. This has prompted me to conclude that effective policies in our institutions are just as important as the research conducted in the laboratories. My life is richer as a scientist and as a citizen of the world, thanks to the Fulbright Program.

NOTES

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The author shares a moment with her host professor at Rutgers University, Dr. Gerben Zylstra.

BIOGRAPHY

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