UNIVERSITY OF PORT HARCOURT

WASTE TO WEALTH: THE TECHNOLOGICAL MICROBIOLOGY WAY

An Inaugural Lecture

By

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ORDER OF PROCEEDINGS

2.45 pm. Guests are seated

3.00pm. Academic Procession begins

The Procession shall enter the CBN Centre of Excellence 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
Lecturer
University Librarian
Registrar
Deputy Vice Chancellor Research and Development
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, invite the Vice Chancellor to make his opening remarks and introduce the Lecturer.

The Lecturer shall remain standing during the Introduction.

THE INAUGURAL LECTURE

The Lecturer shall step on the rostrum, cap and deliver her Inaugural Lecture. After the lecture, she 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
Deputy Vice Chancellor Research and Development
Registrar
University Librarian
Lecturer
Provost, College of Health Sciences
Dean, School of Graduate Studies
Deans of Faculties/School
Professors
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- ❖ Unique Students of UNIPORT
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- ❖ Ladies and Gentlemen.

DEDICATION

To the Almighty God, the creator of heaven and earth.
My helper, the God of love who has been good to me

ACKNOWLEDGEMENTS

I thank God Almighty for his grace and mercies to my life and the strength he bestowed on me. Lord, I am grateful for everything you have done. To him alone be all the glory in Jesus name. Amen.

I would sincerely appreciate the following:
- My beloved Parents of blessed memories - Chief Robinson Nweke Nkenke for showing me the path to education and with faith nothing is impossible and Ezinne Theresa Nkenke (Nee Ngwuocha) for teaching me that hard work depicts excellence and it pays.

- To my wonderful elder siblings- Mrs Chinwe Muo, Late Mr Robinson Chike Nkenke, Dr Esther Nkenke - Iwotor, Mr Reginald Udoka Nkenke, Mr Nwabueze Anierobi Nkenke, Dr Nchekwube Ifeyinwa Uchegbu that stood by me throughout the journey, despite the fact that I lost my father early in life. They showed me the way, made sure that I received good and quality education. I am really grateful for all the sacrifices made towards my life.

- To my uncles and aunts - Chief Mrs Susan Nwandu (Ochendo), Dr PCO Chinwuba, Sir Samuel Nkenke, Mrs Susan Agwuna, Mrs Nwakaego Enekwechi of blessed memories. Engr BO Ngwuocha, Pharm Uche Vicky Onyesoh, Lady Ngozi Nwandu (Adaoba), Lady Chinekwu Ezeala for all your relentless support and love to me.

- To my best friend, the husband of my youth Mr. Emmanuel Chukwuemeka Agwa for giving me the wings to soar and fly. Thanks for your unwavering support, opportunity to pursue my career and be fulfilled in that area.

- To all my beautiful and adorable children- Engr. Miracle, Miss Chidera, Master Chukwuemeka, Miss Kenechukwu and Miss Somtochukwu, for their support, encouragement, tolerance and companionship.

- To my beautiful friends turned sisters - Ebele Anulika Obichi, Jerry-Oleka Yvonne and Titilayo Philip Obi. Thanks for all the assistance in one way or the other. I really appreciate and God bless you.

- To my supervisors at different stages: Late Prof Chibuzo Umeh, Prof FJC Odibo, Prof SN Ibe and Prof GO Abu. Thanks for all your support and efforts towards my academic studies. Your love, reprove and guidance molded me to be where I am today.

- To the days of green horn learning. All my teachers at Amaigbo Lane Primary School (Afternoon session) and Queen's School Enugu, Enugu State, Nigeria. The molding process of cultivation has germinated into a true scholar.

- Special thanks to the foundation laying stone. My lecturers at Nnamdi Azikiwe University, Awka, Anambra State, Nigeria. Prof. Nduka Okafor (Father of Industrial Microbiology in Nigeria) Prof. CN Oyeka, Prof. CC Onochie, Prof. Chris Anyamele, Prof. I Ekwealor and a host of others.
- To the Giants of Microbiology Department, Faculty of Science that believed in me, pruned and guided me to this level

- Late Prof. Oranusi, Prof. GSC Okpokwasili, Prof BJO Efiuvwevwere, Prof Henry Njoku, Prof. Ngozi Odu, am grateful for ensuring that I carve out a niche for my research. And to my wonderful colleagues, thanks for your understanding and cooperation

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- I wish to say a big thank you to the former Dean, Faculty of Science, when I was employed Prof CM Ojinnaka for his keen interest in my life and the past Dean Prof. Emeka Ehirim for his leadership, interest in the peace and progress of the faculty.

Finally, I am grateful to the Vice Chancellor, Prof. Owunari Abraham Georgewill for giving me the opportunity to deliver this lecture.

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PREMBLE

This Journey began with my father teaching me Mathematics in Primary School from Primary four - six after school in preparation for the Common Entrance Examination. He drilled me very well, thus laying a good science foundation. I had the highest aggregate of thirty-six and was posted to Queen's School Enugu for Secondary School. At Queen's School Enugu, I was trained by Mrs Iwobi, Mrs. Udokwu, Mrs. Esege, Mrs. Chanrai, Mrs. Udenka, Mrs. Nwosu (wife of Prof Henry Nwosu former INEC Chairman) amongst others along with my indefatigable Principal Mrs. Ifeoma Gbulie (Wife of Late Connell Ben Gbulie). There, we were taught that Girl child education is important, necessary key to success, believe in ourselves and can do anything. But my biology teacher - Mrs Ojukwu and Chemistry teacher Mr. Okoli were the ones that made me show keen interest in science because of their style and manner of approach to these subjects. They made it so easy to understand and assimilate behold I fell in love with them.

I gained admission into Nnamdi Azikiwe University Awka, Anambra State to study Applied Microbiology and Brewing Technology. The concept of industrial Microbiology and Brewing was introduced by Prof. Nduka Okafor and Dr T. I Anyanwu. The course became highly technical and engineered me into Technological Microbiology with waste materials. My undergraduate project “Conversion of corncob waste into ethanol using yeast cells isolated from fresh palm wine juice. The research topic got me curious, doubtful whether it will work out or not, really worried and puzzled but very enthusiastic to see the outcome. After the second fermentation period, the broth was distilled and I was able to obtain bioethanol.

During my PhD research, I was introduced to the art of cultivating microalgae by blooming. using different animal wastes. The microalgae – *Chlorella vulgaris* became a wonder bug that could be engineered technically for the production of diverse products due to its inherent physicochemical compositions and the stable cell structure that is easily amenable to manipulation. From there the road to utilization of waste and its management strides on, leading me to the exploration of the inherent properties of the microalgae and their possible potentials that can be harnessed. The research process was very tough, tedious, quite interesting, the path continued to be intriguing and at the same time mind blowing. This is because as a microbiologist I am not worried about contamination of any sort as the microalgae contains an inherent antibiotic called ‘chlorellin’ that helps it not to be contaminated.

From that time, my work with waste materials began leading to their use, management and utilization for the production of useful biological products. Today, this research has been tailored to waste to wealth: The Technological Microbiology way.

1.0 INTRODUCTION

MICROBIAL WORLD

Living things are found on earth, some are visible such as plants and animals while the others are not visible to the eye. These ones that are not visible to the eye are grouped into a collection called microorganisms. They are among the most successful living things which can be found everywhere. Their size belies their economic importance thereby contributing to the welfare of life as beneficial for making a range of foods and drinks which support enormous industries, breaks down organic materials into nutrients or harmful by causing debilitating and devastating diseases. They require special techniques to study and can only be seen with the aid of a microscope. Their club members include – Bacteria e.g *Salmonella typhi*- typhoid fever, *Vibrio cholerae*-cholerae, *Clostridium tetani*-tetanus. Fungi e.g Zygomycetes - mucor, Deuteromycetes - candida, Ascomycetes – yeast. Viruses e.g Picornaviruses - common cold, Togaviruses - yellow fever, Pox virus - smallpox. Algae e.g Golden brown algae – diatoms, Chlorophyta – chlorella, Cyanobacteria – nostoc. Protozoa e.g Amoeba, Paramecium, Euglena. The study of these members has evolved into different branches of microbiology which has transformed into various areas to meet the diverse human activities on earth. Figure 1 shows the different branches of Microbiology which includes - medical, food and dairy, molecular, genetics quality control, pharmaceutical, agricultural, environmental, industrial and biotechnology. My research area falls under environmental and industrial microbiology which has been tailored into technological microbiology. As a result of modernization, microbial techniques for cultivation have improved rapidly thus incorporating diverse biotechnological techniques that allow the identification of microorganisms easily and accurately. These activities have increased industrial activities incorporated into applied science allowing for the generation of new and improved products and services called 'technological microbiology'.

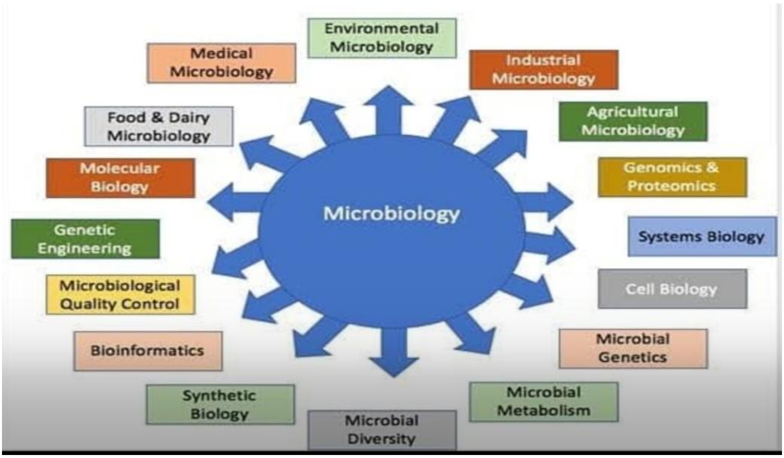


Fig. 1. Different branches of Microbiology

Talaro et al., (2015)

My journey into waste management and its utilization started during my undergraduate days when my supervisor-Prof. Chibuzo Umeh asked me to work on the possibility of obtaining alcohol using corn cob as starting material and yeast obtained from fresh palm wine (Umeh and Agwa, 2001). The proximate analysis of corncob wastes as can be seen in Table 1 shows high contents of carbohydrates and crude fibre.

Table 1. Proximate analysis of corncob wastes

Parameters	% Value
Carbohydrates	51.03
Crude proteins	7.66
Crude ash	3.00
Crude fibre	26.10
Crude fat	4.50
Moisture content	7.72

The result showed that corncob waste can be used as a good starting material for bioethanol production thereby removing this aesthetic detrimental waste from the environment. The waste was converted into utilizable product for human consumption in a non-polluting and profitable manner. The research led to sourcing ways of removing the menace caused by corncob on the street and mitigating environmental pollution. The outcome led me to the choice of waste management and its utilization because they

i. Will serve as feedstock for industrial purposes thereby mitigating pollution.
ii. Utilize these renewable resources which will enhance the sustainability of the environment essential for development and bioeconomy increase.
iii. Are biodegradable and ecofriendly.
iv. Readily available and cost effective.
v. Have very low toxicity with an array of diverse applications.
vi. Contain wide range of bioactive compounds which serves as an important source of natural products for human health.

2.0 TECHNOLOGICAL MICROBIOLOGY

Technological Microbiology is a new concept, a very complex technique, involving the expression of microorganisms, and their derivatives that are used in microbial biotechnology to generate industrial and/or environmental products that impact life daily. They make use of living things, biological systems, or its derivatives to make, modify products or processes for specific use. Plants, animals, fungi, and bacterial cells, including their derivatives such as enzymes, artificial membranes, and viral particles can be used and applied accordingly to diverse areas such as food, chemical and fuel, agricultural, environmental, material, medical and pharmaceutical industries. They depend on the use of various tools and applications that tends to overlap with related fields of engineering. A typical example, in one of our researches during the growth of flue gas using *Chlorella vulgaris*, this investigation was carried out with the assistance of Engr. James Amukwo from Department of Petroleum and Gas Engineering who fabricated the pressure regulated gas cylinder used to store flue gas obtained from the investigation. The application is expanding and advancing rapidly due to the emergence of newer technologies and are of various types.

2.1 TYPES OF TECHNOLOGICAL MICROBIOLOGY

1. **RED TECHNOLOGICAL MICROBIOLOGY** deals with application in medical microbial technology – biology of pathogens, immunological knowledge, animal medicine and pharmaceutical industries where diagnosis is made, drugs developed and delivered to the public for use.

2. **GREEN TECHNOLOGICAL MICROBIOLOGY** deals with applications in agriculture and food production by using genetically altered plants and animal for producing ecofriendly products that can solve certain farming problems by controlling pests and diseases; improve food safety, security, science and methods of preservation; serves as an alternative to traditional agriculture by improving plants and animal protection; plays a significant role in managing waste by the production of biogas and use of plants in phytoremediation to combat pollution.

3. **GREY/WHITE TECHNOLOGICAL MICROBIOLOGY** deals with application in environmental and industrial production. Microbial cells are used as commodity during biological processes to produce useful efficient energy products, remove pollution and maintain biodiversity. This is the area where my research interest lies on by using microorganisms for production of useful biological products. For example, Plate 1 shows the use of microalgae such as *Chlorella vulgaris* for the production of useful biological products (Miriam et al., 2024).

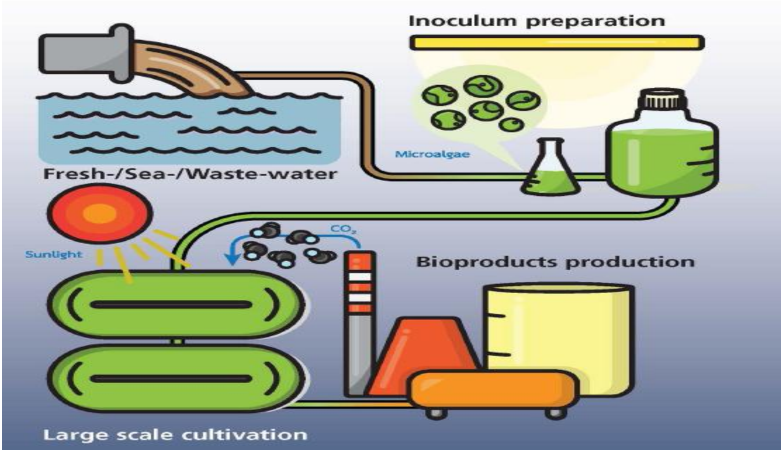


Plate 1. Grey/white technology for sustainable industry and environment

Several comparisons arose between the possibilities generated by classical and technological microbiology which has led to the development of new techniques and their improvement in terms of product and services. The applications of microorganisms for obtaining new and improved product are compared with the classical methods with new techniques that were added leading to novel products. Classical application of microorganisms is used for the production of drugs such as antibiotics, fermentation processes for the production of alcohol, milk etc. They are now technically transformed to various industrial products with specific purposes. E.g bioethanol, organic acids for diverse purposes. They make use of different materials which are obtained from the environment for different biological processes and are referred to as starting materials, raw materials or waste products. These waste products in technological microbiology are called biomass.

2.2 BIOMASS

Biomass are substances received from living organisms that can be used for bioenergy production. They can be formulated to serve as an attractive source of valuable substrate for industrial production. It's one of the best focused alternative energy sources, serves as a renewable resource and fixes CO_2 in the atmosphere through photosynthesis. There are various sources such as Wood residues – processing wood such as firewood, chips, pellets, sawdust. Agricultural crops – farming activities, food processing and preparations e.g peels from crops. Solids – residues from sewage, garbage, litters and other sources. Animals – mammals and livestock e.g production of biogas, biofuel, lipids etc. Industrial effluents – waste water from industries e.g municipal, food processing, dairy industries etc. Figure 2 illustrates the various types of biomasses obtained from living things. They are classified by the life kingdoms and other groups with their sizes. These biomasses are used in technological microbiology for development, production and their application for various purposes.

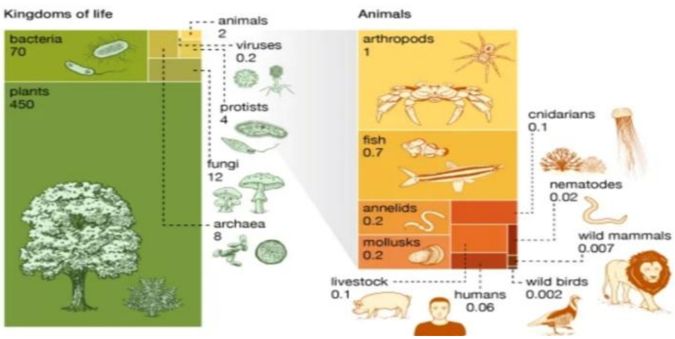


Fig. 2. Types of biomasses obtained from living organisms

Encyclopedia Britannica (2024)

2.3 BIOPROCESSING CONCEPT

Nonrenewable resources have been in use for a long time, from the 21st century there has been a sudden drive for renewable resources in production so as to preserve agriculture, protect the environment, tackle global warming and achieve zero waste production. This has led to the concept of bioprocessing which involves transforming of the essential component of biomass into sustainable source for the production of useful biological products. They have been classified into three generations based on the type of biomass used for processing.

1. First generation makes use of crops with high starch and glucose content as source of feedstock. E.g., corn starch, cassava starch, yam starch, sugarcane, vegetable oil etc. They are used to satisfy energy demand rather than food demand (Jambo et al., 2016; Naik et al., 2010).

2. Second generation uses agricultural – industrial residues that are not of interest to food demand such as lignocelluloses materials - rice husk, wheat straw, cotton stalk, corncob, sugarcane molasses and industrial waste effluents (Hassan et al., 2019; Ruiz et al., 2013).

3. Third generation makes use of organisms from diverse habitat especially aquatic such as macroalgae and microalgae. Microalgae are the preferred choice because of their unique properties and potential, they depend on abiotic factors (Sharma et al., 2022; Mehariya et al., 2022; Begum et al., 2016). The microalga *Chlorella vulgaris* is of great interest due to its potential use in different areas. Microalgae reproduce themselves using photosynthesis to

convert sun energy into chemical energy, completing an entire growth cycle every few days (Sheehan et al., 1998). Moreover, they can grow almost anywhere, requiring sunlight and some simple nutrients, the growth rates can be accelerated by the addition of specific nutrients and sufficient aeration (Irene et al., 2020).

Among biomass, algae (macro and microalgae) usually have a higher photosynthetic efficiency than another biomass (Chisti, 2007). Microalgae reproduce themselves by using photosynthesis to convert sun energy into chemical energy, completing an entire growth cycle every few days (Sheehan et al., 1998). Moreover, they can grow almost anywhere, requiring sunlight and some simple nutrients, the growth rates can be accelerated by the addition of specific nutrients and sufficient aeration (Irene et al., 2020). These wastes are removed from the environment to drive home the environmental management goals for a clean and green technology thereby promoting good health, mitigate pollution, and achieve sustainability. They are pretreated and manipulated to produce products that are useful to the society, thus converting waste to wealth the technological microbiology way.

3.0 THE MICROALGAE - *Chlorella vulgaris* AS A SOURCE OF BIOMASS

For decades strains of *Chlorella* (Chlorophyceae, chlorococcales) have served as a model organism in plant physiology, biochemical research and as a source of renewable energy (Huss etal., 1999; Krienitz et al., 2004). The species of

Chlorella have formed various intracellular relationships with other organisms and have been used in many ways to produce diverse products of environmental importance (Chisti, 2007). *Chlorella* has existed on earth for more than 2.5 billion years, they belong to the phylum chlorophyta, order chlorellales and family chlorellaceae. Safi et al., 2014 reported the scientific classification of *Chlorella vulgaris* as shown in figure 3

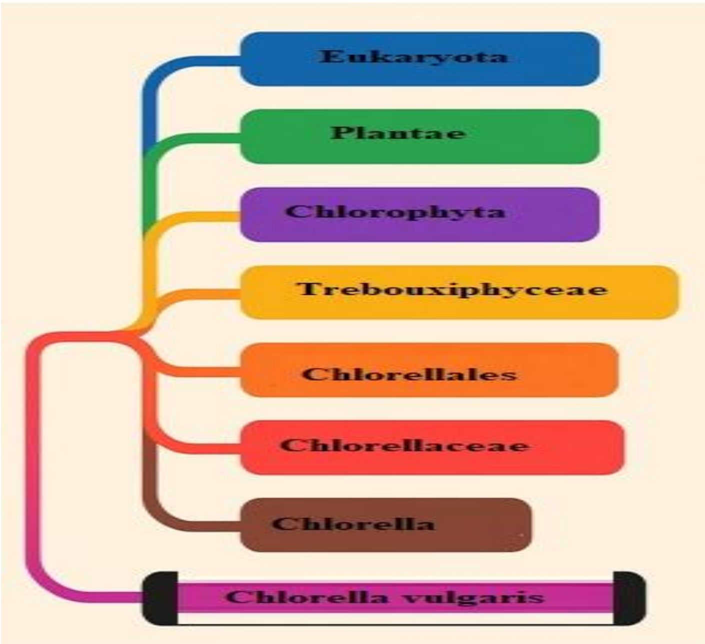


Fig. 3. Scientific classification of *Chlorella vulgaris*

Miriam et al. (2024)

It is a single- celled green algae, spherical, about 2-10μm in diameter, non-flagellate and has a polysaccharide membrane that can absorb large amounts of dioxin, lead, mercury and other toxins. *Chlorella* contains the green photosynthetic pigment chlorophyll-a and -b in its chloroplast, which gives its characteristic deep emerald green colour, multiplies rapidly requiring only carbon (IV) oxide, water, sunlight and a small amount of mineral to reproduce. They are non-motile organism that reproduces by the production of asexual autospores which divides into daughter cells in the process known as autosporulation (Safi et al., 2014). They are attractive source of viable inexpensive carotenoids, pigments, proteins and vitamins that can be used for the production of different value-added products (Running et al., 2002; Bremus et al., 2006; Cardozo et al., 2007). It can be found in various environments with great diversity in freshwater, marine and terrestrial environments. Because of the presence of chloroplast in its cell, has high photosynthetic ability and can grow rapidly under autotrophic, mixotrophic and heterotrophic conditions for production of *Chlorella vulgaris* (Fig. 4).

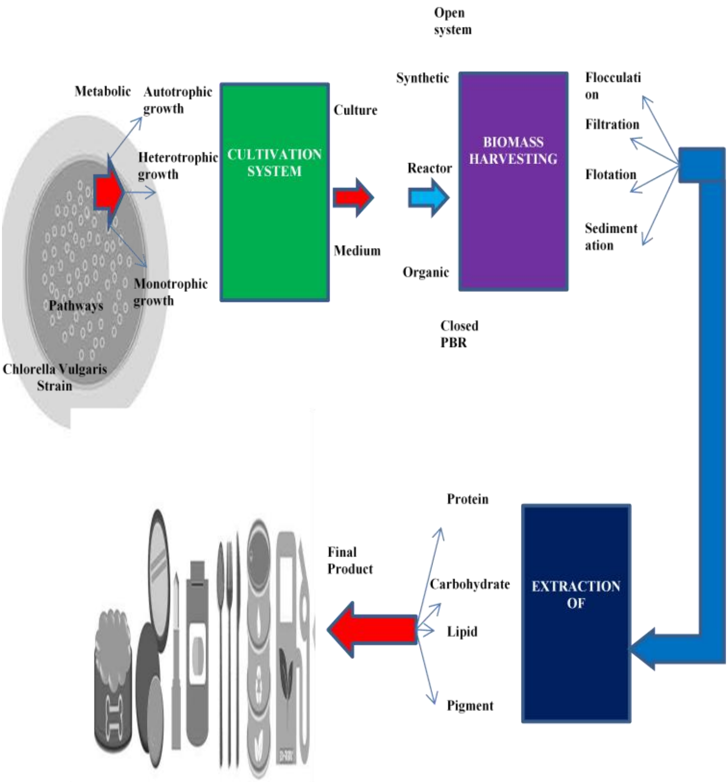


Fig. 4. General diagram process of Chlorella vulgaris production

Miriam et al. (2024)

3.1 Biochemical components of *Chlorella vulgaris*

Chlorella vulgaris is a wonder bug that can be bloomed with any type of waste material, subsequently transformed into useful biological products. This is because of their cell constituent that is rich in biomolecules (Protein – 56.0; Fat - 10.03; Carbohydrate – 13.7; Ash – 1.50; Moisture content – 6.6 and others – 11.9). As shown in Table 2, these are essential nutrients that can also be necessary for the human body present in their cell. Plate 2 showing different food sources that can also be found in microalgae, this signifies that it contains all the essential nutrients necessary for life. These food sources are important for health and assisting it to fight against diseases and infections. *Chlorella vulgaris* was isolated from the mouth of New Calabar river, bloomed using different animal waste with several waste water and subsequently served as feedstock for diverse purposes (Agwa et al., 2012). They were bloomed under natural or artificial illumination, cultured using different animal waste extracts and technically transformed into various useful biological products (Plates 3 and 4). Plate 5 shows the microscopic appearance of *Chlorella vulgaris* as can be seen under light microscope.

Table 2. Composition of vital minerals for human body function present in *Chlorella vulgaris*.

Mineral	Content (mg/100g)
Ca	1425 ± 10.3
Mg	851 ± 9.4
Zn	293 ± 4.5
Na	101 ± 2.8
K	1197 ± 17.0
Cu	48.4 ± 27.9
Fe	82.2 ± 37.6

Irene et al., (2020)

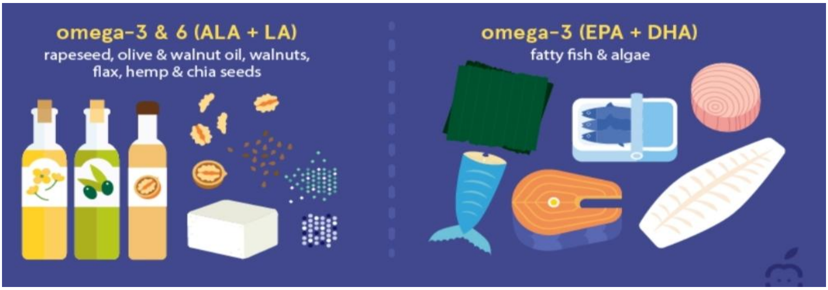


Plate 2. Different food sources that can also be found in microalgae

Plate 3. Initial blooming under natural illumination

Plate 4. Final blooming under natural illumination

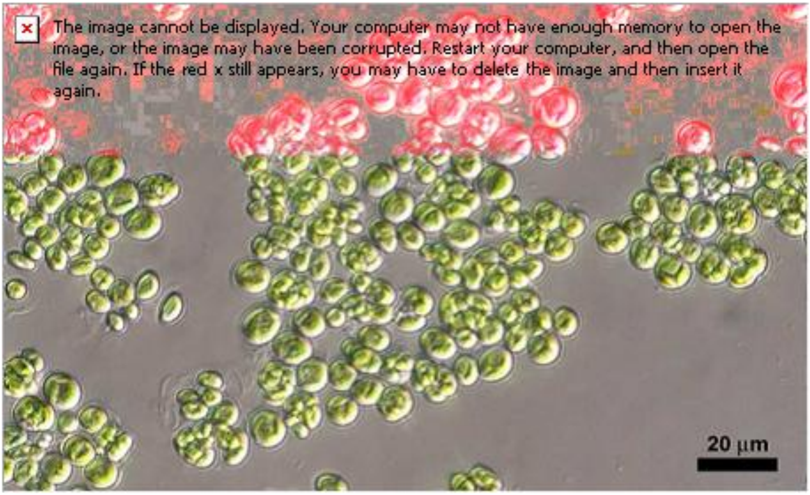


Plate 5. Microscopic appearance of *Chlorella vulgaris* as seen under light microscope

The potential opportunity of using different animal waste for microalgae growth revealing the value-added products that can be obtained. Thus, highlighting the concept of waste utilization, as well as greenhouse emission reduction and enhance multiple waste management as waste to bioenergy production. This established an inexpensive and sustainable protocol for the cultivation of the microalgae with an alternative for pollution control. The high biomass yield can be converted into useful biological products of industrial importance. Biomass production using the different animal wastes revealed the enormous potential of using these animal wastes as raw material (Agwa et al., 2012a and 2012b). Different microalgae species are obligate phototrophs, they can be adapted to a variety of environmental conditions such as temperature, light, pH, availability of O_2 and CO_2 in terms of growth characteristics. They mainly require light for growth, resulting in high growth rate and productivity as can be seen from the natural illumination using chicken waste (Mata *et al*., 2009). The conversion of light to chemical energy is the ultimate responsibility for driving the production of biomass for a wide variety of products Agwa et al. (2013); Agwa and Abu (2014).

Table 3: Proximate analysis of different animal wastes

Parameters	Goat waste	Pig waste	Cow dung waste	Grass cutter waste	Chicken waste
Moisture	28.50	7.60	6.60	11.70	8.8
Lipid	3.30	5.90	2.85	6.70	1.20
Ash	32.50	55.30	4.50	7.90	55.90
Protein	8.75	6.56	4.38	8.25	9.63
Carbohydrate	3.91	2.03	2.94	2.91	2.14
Crude Fibre	23.34	22.61	78.73	65.54	22.33

Table 4: Physicochemical properties of animal wastes extracts from biomass

Parameters	Goat waste	Pig waste	Cow dung waste	Grass cutter waste	Chicken waste
pH	7.22	6.32	6.28	6.0	6.66
NO_3	5.06	5.06	4.6	2.61	3.83
PO_4	7.04	11.26	16.5	8.24	8.8
BOD	240	320	270	320	160
COD	844	1620	1390	1540	1796
Conductivity	272	593	370	915	827
Temperature	29.6	29.6	29.6	29.6	29.6

The investigation revealed that poultry waste proved to be the best source for microalgae growth because of the presence of the necessary essential micronutrients as can be seen in Table

3 and 4. This is because it has been a traditional organic alternative to inorganic fertilizer. This poultry waste is now being used in the bioremediation of oil polluted environment as it enhances the degradation of petroleum hydrocarbon (Ezenne et l., 2014; Yahemba et al., 2022; Okpanachi et al., 2025).

In the course of my research, *Chlorella vulgaris* was grown under unfavorable condition, the elemental composition of *Chlorella* oil revealed long chain fatty acid between C16-C18 indicating the presence of palmitic acid, linoleic acid and oleic acid with potential of biodiesel production. There is therefore a potential of algal biotechnology in the area of renewable, alternative green energy (biofuel/bioenergy) production using inexpensive growth media formulations such as animal wastes which support the growth of *Chlorella vulgaris*. Other value-added substances such as biochemical and pharmaceuticals can also be obtained from the biomass. Furthermore, Agwa and Abu, (2016) monitored the potential of various nitrogen sources for the growth of *Chlorella* sp. under phototrophic condition utilizing molecular Co_2 from the atmosphere. The microalgae have the ability to metabolize urea which can be hydrolyzed to ammonia by the enzyme urea carboxylase changing the intracellular fatty acid content converting them into forms suitable for lipid production. The in-vitro activity of *Chlorella vulgaris* extracts on selected clinical isolates was monitored by Agwa et la. (2018). The result shows that the extract has good antimicrobial activity and could be explored as a source of natural product for controlling some bacterial and fungal infections.

4.0. Technological Microbiology: Development and Applications

Microbiology has been exploited globally, especially in biological processes for the production of different products. The use of microorganisms in technological microbiology leads to the production of primary and secondary metabolites (Plate 6). They can be applied in various by using fermentation processes based on end-product application. These are based on:

1. Biomass with a profitable end product e.g. bioethanol, biofertilizer, biofuel.

2. Extracellular metabolites: these are mainly used as chemical compound that serve as intermediates of microbial biochemical pathways involved in processes in which different products are produced and can be divided two groups:

   a. Primary metabolites (produced during the growth phase of the organism, e.g., ethanol, citric acid, glutamic acid, lysine, vitamins and polysaccharides)

   b. Secondary metabolites (produced during the stationary phase, e.g., penicillin, cyclosporin A, gibberellin, and lovastatin).

3. Enzymes and other proteins (intracellular components): are used during fermentation processes, the cells are lysed, harvested, purified and crystallized.

4. Substrate transformations: the finished product is biologically transformed.

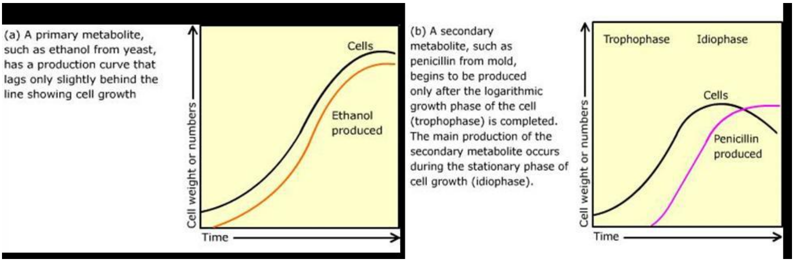


Plate 6. Production of primary and secondary metabolites

The process of industrial production of microbial metabolites can summarized as in Plate 6. The basic steps involved are: Screening, selection, maintenance of source microorganism for the production of target metabolite (primary or secondary). Optimization and standardization of growth medium and conditions (choice of fermenter vessel, aeration, temperature, agitation, pH, etc.) for large-scale (fermentation) protocol. Active, pure culture in sufficient quantities is used to inoculate growth medium in fermenter. The growth of the organism in the production fermenter under optimum conditions for product formation. This leads to upstream processing involving isolation of the microorganisms and raw material needed for the growth of the microorganism and production of the desired product (Fig. 5). The microorganism can be grown in a fermentation tank or bioreactor and the production of the desired compound is the fermentation process and subsequent transformation. This process results in the extraction, purification and characterization of the desired product from the cell medium or mass and disposal of effluents produced by the process.

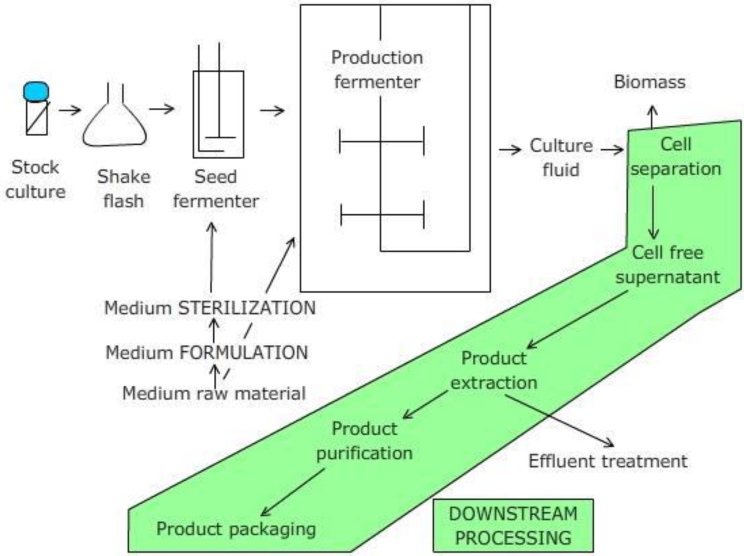


Fig. 5. Scheme for industrial production of useful biological products

Improvement in this technique lead to the implementation of waste management and its utilization for the production of useful biological products thus converting waste to wealth the technological microbiology way.

4.1 Algae Technological Microbiology

Algae technological microbiology is a novel and rare area in microbiology which require certain techniques and patience to navigate. There is severe shortage of trained research scientist in this area because of the difficulties involved in their cultivation and storage. The contact I had when I was employed to work with Uniport exposed me to this rare and very difficult area. My supervisor Prof GO Abu, was the one who introduced me to the field of algae morphology and physiology. We started with work on the waste water from Obagi flare pit in search of *Spirulina* sp. but later changed to *Chlorella* sp. which was bloomed by using water from the New Calabar River and pond water. The enormous potential embedded in the cells of algae spurred me to search of their numerous possible uses and as an environmental /industrial microbiologist what they can be used to produce and applied in life. The diverse applications of technological microbiology can be observed from the figure 6 below

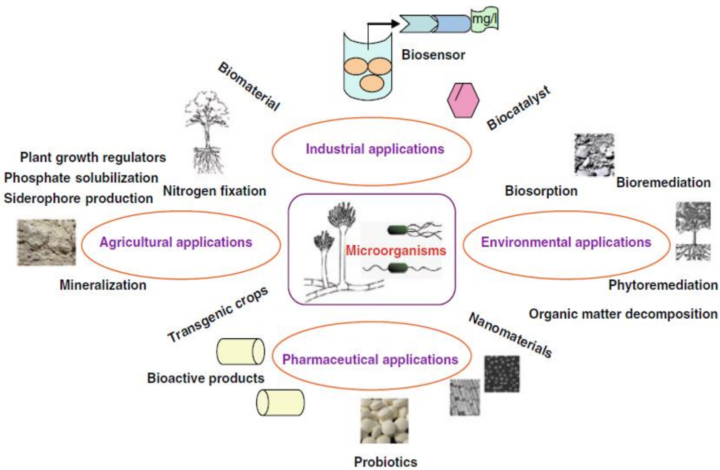


Fig. 6. Scope and applications of Technological Microbiology

Ahmed et al. (2011)

4.2 Applications of Technological Microbiology

Technological microbiology is a fast-growing field that cuts across diverse areas in life. It is becoming interesting, quite challenging but are used in the development and production of various products which encompass a wide range of applications. These are

A. Environmental: Wastes constitute a great nuisance to the environment; possible ways of combating them to mitigate pollution and improve productivity were sought. In the course of our various investigations, these wastes have proven to be of great value and resource with vast potential in technological microbiology, they reduce menace in the environment and a demonstration of sustainable resource management. Different macronutrients in waste material were investigated for the cultivation of microalgae. Here, we formulated growth media for microalgae cultivation using cassava peel and effluent wastes (Agwa et al., 2014, Nwankwo and Agwa, 2019) domestic and restaurant waste water (Agwa, et al., 2018); hot and cold-water infusions of poultry droppings (Effiong et al., 2018), which were meant to be a waste to wealth. The research explores the different biomolecules in microalgae biomass as a renewable alternative green energy resource. Our findings showed a steady growth during the growth phase indicated that it is possible due to the presence of nitrogen and phosphorus which are essential elements required for growth and metabolism (Fig 7). This signifies an increase in the growth rate and doubling time of the microalgae

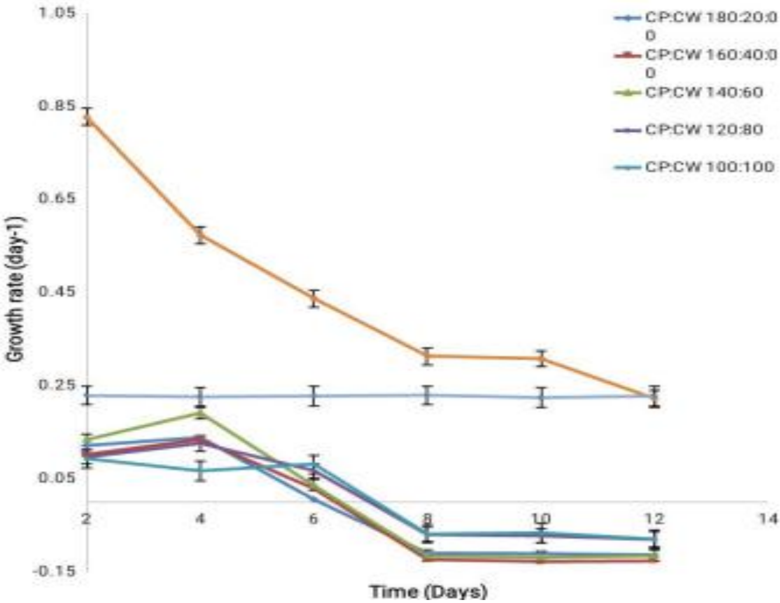


Fig. 7. Changes in growth rate with time of *Chlorella vulgaris* obtained from various ratio of cassava peel water and cassava waste water

This showed an effective waste management and its utilization which can be harnessed for production of microbial products. The potential of algae technological microbiology by using an inexpensive growth medium formulation for microalgae growth is butresses. This biological process utilized ATP/NADPH to fix and convert carbon (IV) oxide captured from the atmosphere to produce glucose and other sugars through the calvin cycle metabolic pathway in which the cassava peel produced more lipid than the effluent as can be seen from fig 8.

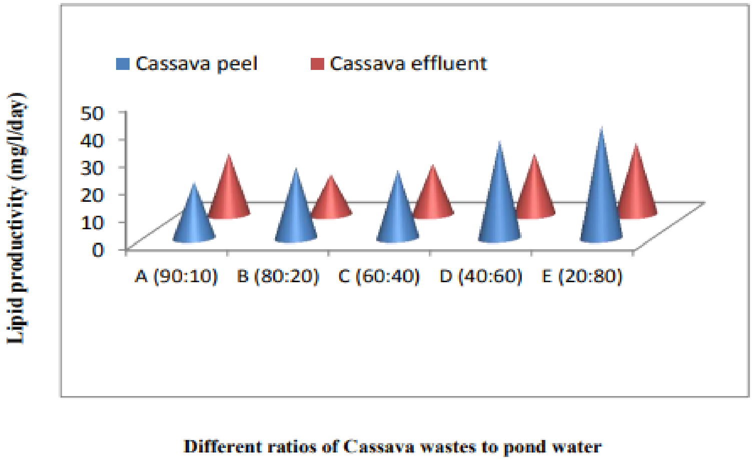


Fig. 8. Lipid productivity of microalgae grown on different cassava wastes.

The environment is being challenged due to the vast release of greenhouse gases causing severe damage to the climate thus necessitating the need for renewable energy. This is as a result of threats of severe pandemic leading to reduced agricultural productivity, water shortage and contamination. These challenges can be addressed by wide variety of microorganisms as they play major roles in metabolic action within the ecosystem (Ahmed et al., 2011). The vast potential of microalgae identified unveiled the green technology of growing *Chlorella* sp. Neboh et al., (2014) cultivated *Chlorella* sp. by using flue gas emission from a generator and waste effluent from a fertilizer company. Plate 7 shows the initial growth of *Chlorella* sp using flue gas indicating no colour change as the microalgae is adapting to the environment and cell multiplication has not started. Our findings showed that they are good source of feedstock for the production of renewable energy because of their rapid growth rate. Plate 8 shows visible growth of *Chlorella* sp using flue gas indicating colour change to green as the microalgae cell multiplies spontaneously. Thus, necessitating the need for renewable energy supplies that do not cause environmental harm but a good bioeconomic sustainability.

Plate 7. Initial Growth of *Chlorella* sp. on different Concentration of flue gas

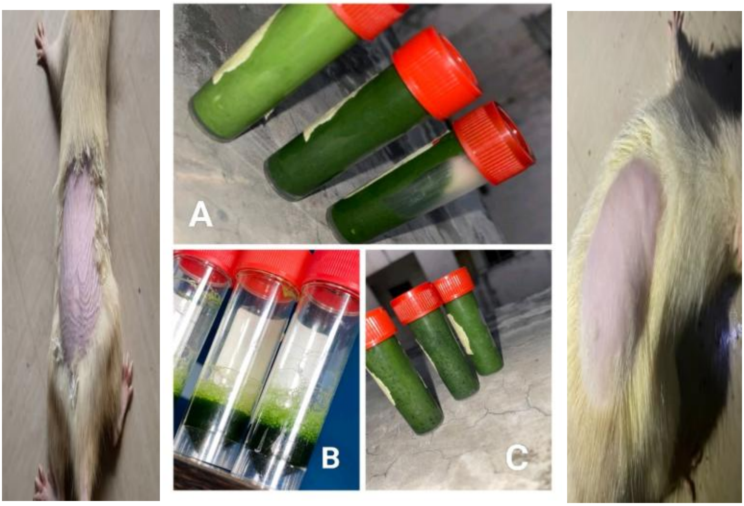
Plate 8. Final growth of *Chlorella* sp. on different concentration of flue gas.

B. Agricultural: This is an area that is concerned with plant mediated microbiology involving the use of microorganisms in soil fertility, serves as feedstock to livestock and in inhibition of phytopathogens. Agwa et al., (2017) and (2018) considered the use of *Chlorella* sp. as source of biofertilizer for increasing the soil fertility and productivity. Here our findings indicated that *Chlorella* sp. can act as an efficient, good and safe alternative to chemical fertilizer which improves soil nutrients for greater productivity of *Hibiscus esculentus* (okra) and *Telfairia occidentalis* (fluted pumpkin) as can be seen from Plate 9.

Plate 9. Pictures speaks of the plants grown with *Chlorella vulgaris* biomass

Likewise, *Chlorella vulgaris* was also used as a source of feedstock for fish, chicken and rabbit, tremendous results were obtained with an increase in weight, size and height.

C. Pharmaceuticals: One important aspect of technological microbiology is the use of microorganisms for the production of biopharmaceuticals, which are drugs and cosmetics produced using biological processes rather than chemical synthesis. Examples of biopharmaceuticals include cosmetics, drugs, vaccines, etc. ln our research, the microalgae *Chlorella vulgaris* due to their ability to grow quickly and produce large amounts of biomolecules was used as a feed stock for the production of cream, soap and Vaseline and their effect on whiskers rats were monitored. Plate 10 shows a picture of the whisker rats before and after treatments using the different cosmetics. The histological study conducted showed that it has no detrimental effect on the skin and contains antioxidants that will reduce wrinkles and has anti-aging properties.



Before Treatment **After Treatment**

A: ***Chlorella vulgaris*** **cream; B:** ***Chlorella vulgaris*** **soap; C:** ***Chlorella vulgaris*****vaseline**

Plate 10. Picture showing the various cosmetics and treatments on whisker rats

D. Industrial: Microbial screening is a very important and necessary step that led to the identification of novel biomolecules to unveil their numerous potentials. This technique relies on specific search for microorganism from natural sources, their analysis and production to obtain the desired products. It involves selection, isolation and characterization of microorganisms, design of suitable media and composition, product development and production as it affects everyday life (Okafor and Okeke, 2018).

Screening activities was carried out to develop new products from dense population of microbial community, their environmental interactions, optimal condition of growth and productivity. Various biomasses such as biological wastes from food, agricultural, municipal and industrial wastes as well as edible and non-edible plants has been identified as alternative bio-oil sources for energy application. Microorganisms were effectively used in obtaining chemicals and fuel through microbial metabolic pathways by using different renewable resources.

I. **Biofuels:** Different microorganisms such as bacteria and fungi can be used to convert plant sugars or other biomass into biofuels. Bioethanol was produced from *Chlorella vulgaris* cultivated with unripe plantain peel extract (Agwa et al. 2017). The study showed that unripe plantain peel can be used as a sole carbon source for the process. The best result was obtained with a co-combination of *Saccharomyces cerevisae* and *Aspergilus niger* as can be seen in figure 9. The process of converting biomass to fermentable sugar is a major constraint for bioethanol production due to high cost of enzyme and complication associated with their removal. This led to the search for low-cost enzyme and its combination to enhance biomass hydrolysis. Microbial biomass was hydrolyzed using amylase and cellulase enzyme, the result showed that these crude enzymes can increase microalgae biomass yield for bioethanol production.

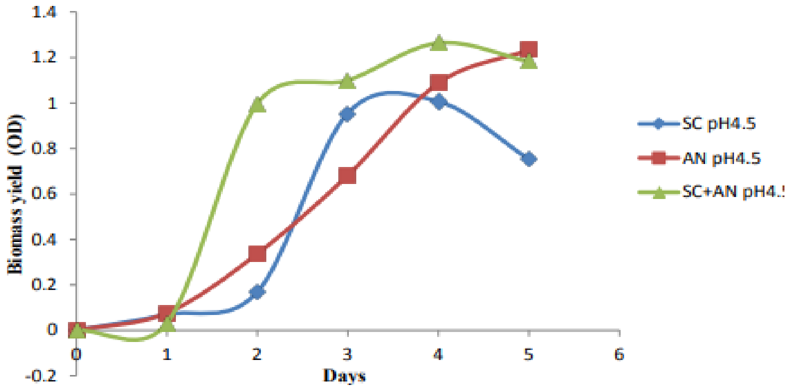


Fig. 9. Biomass yield during fermentation.

Some interesting studies was carried out on unutilized mango seeds that are regarded as waste. These mango seeds served dual purpose of being utilized in form of mango kernel powder as a cheap and renewable alternative carbon source. They were used for large-scale production of fungal lipase; to produce mango kernel oil which was used as a low-cost vegetable oil feedstock for the production of biodegradable and renewable biodiesel and biolubricant with top-notch physiochemical (Table 5) and tribological properties (Akinduyite et al., 2022). Likewise, lipolytic fungi isolated from oil contaminated soil environment with functional *lipA* gene were used for lipase production. The mango biolubricant produced conformed to the International Standard Organization – Viscosity Grade (ISO-VG) 46 specifications and can be used for industrial and automobile applications.

Table 5. Comparative analysis of Physicochemical and fuel properties of Mango Biolubricant with Petroleum based lubricant (Oando Super Oleum SAE 40)

PHYSICOCHEMICAL AND FUEL PROPERTIES	BIOLUBRICANT ENHANCED WITH *Candida orthopsilosis* PMS3 LIPASE	BIOLUBRICANT ENHANCED WITH *Fusarium proliferatum* PMS4 LIPASE	BIOLUBRICANT ENHANCED WITH POTASSIUM ETHOXIDE	PETROLEUM BASED LUBRICANT(OANDO SUPER OLEUM SAE 40)	ISO VG – 46 STANDARD
Colour	Light yellow	Light yellow	Greenish yellow	Greyish yellow	-
Odour	Pleasant	Pleasant	Pleasant	-	-
Physical state at 30°C	Liquid	Liquid	Liquid	Liquid	Liquid
Moisture content (%)	0.030 ±0.002	0.031 ±0.001	0.029 ±0.001	0.021 ±0.001	-
Density (g/ml)	0.889±0.001	0.886±0.003	0.885±0.001	0.892±0.003	≥0.880
Acid-value (mg/KOH/g)	0.325±0.007	0.387±0.001	0.394±0.003	0.495±0.008	<0.5
Kinematic Viscosity at 40°C (mm^2/s)	48.94±0.16	48.71±0.11	48.09±0.08	49.93±0.03	41.4 – 50.6
Kinematic Viscosity at 100°C (mm^2/s)	8.62±0.08	8.50±0.04	8.23±0.06	7.25±0.05	>4.1
Viscosity Index	154.92±2.09	151.78±0.72	145.53±1.63	103. 80±2.09	>90
Flash point (°C)	239±1.41	237±1.41	231±1.41	224±2.83	>212
Pour point (°C)	-8±0.00	-7±1.41	-5±1.41	-12±0.00	-

II**. Microbial organic acids:** These are acids produced by microorganisms through fermentation; they are widely distributed in nature as normal constituents of plants and animal. They constitute a notable group among the building block chemicals that can be produced by microbial processes**.** Most organic acids occur from renewable carbon sources, serve as natural products or intermediates of microbial metabolism present in metabolic processes. Microbial production of organic acids by using different biomass as source of feedstock was conducted. Several outputs to these investigations are discussed as follows:

1. African star apple (*Chrysophyllum albidum*) peel commonly called udara was used for the production of citric acid using *Aspergillus niger*. This is a typical application of waste to wealth as a way of minimizing agro-based environmental pollution for cleaner environment (Dienye et al., 2018). Citric acid provides energy in microbial cell and convert it into carbon (IV) oxide and water, they can be used to treat metabolic acidosis, kidney stone prevention, as anticoagulant in blood collection as flavoring and preservative in food and beverage industry, used as buffer to maintain stable pH, provide the carbon skeleton for the synthesis of various biomolecules, used in various cleaning products, acts as a natural disinfectant and as a chelating agent. Likewise, palm oil waste effluent, palm empty fruit bunch and palm waste cake were also used for the production of citric acid using *Chlorella vulgaris* as a source of feed stock that can be used in oil field activities - as a corrosion inhibitor, scale removal, clay stabilization, iron sequestering and for hydraulic fracturing (Asoka et al, 2021a; 2023).

2. Protein rich residues of beans, groundnut and powdered milk were used for acetic acid production. Our finding indicated that protein rich residues can serve as reservoir for the production of acetic acid, shedding more light on the diversity of bacteria within the Nigerian environment. These acetic acid bacteria act as precursor for acetic acid production which can be used for the production of various products in the industries (Onyenegecha et al., 2020). They can be used for Food preparation as a preservative, medicinal use as an antiseptic, household use as a cleaning agent to remove stain,

industrial applications as a solvent for ink and coating and production of various cosmetic products such as hair conditioners, shampoos and perfumes.

3. Wet cells of *Chlorella vulgaris* was used for the production of lactic acid. This is a naturally occurring acid produced by fermentation processes which is easily biodegradable; a major component in the production of fermented foods that can be used in flavoring and preserving confectioneries. It provides carbon source that supports microbial activity in bioremediation processes, reduces environmental impact of oil spill, can be used in drilling fluids and well stimulation (Agwa et al., 2021). They can be used in

- Food Industry as preservatives, flavoring agent, curing agent and for acid adjustment,

- Cosmetic Industry as in skincare -cleansers, exfoliates, hydration, anti-aging, pigmentation reduction and serums.

- Pharmaceutical Industry as a ringer's lactate solution, and additives.

- Medical Applications for diagnosis of lactic acidosis and its treatment.

- Other Industries as in textile, leather, bioplastics/polymer production.

4. Wet cells of *Chlorella vulgaris* was used for oxalic production, they were further optimized with cassava whey,

groundnut shell and banana peel to enhance productivity. As technological microbiologist we were still working to gain a complete understanding of microbial cell factories. Several models were used to represent fermentation processes to determine oxalic acid synthesis, biomass and substrate consumption. The production kinetics of the fermentation study was fitted into the Monod, Leudeking-Piret and Andrews's kinetic models. Leudeking-Piret and Monod indices were indicative of the fact that the substrate utilization was associated with the production of the oxalic acid (Fig. 10).

$$\mu = \frac{Ln\,(\frac{N1}{Ni})}{T1 - T0} \quad (1)$$

$$\mu x = \frac{Ln\,(dx)}{(dt)} \quad (2)$$

Given that $\mu = \frac{\mu max}{(Ks+S)}$ (3)

$$\mu = \frac{\mu \max\, s}{(Ks+S+s2/ki)} \quad (4)$$

Where μ = specific growth rate (per day)
NI and Ni = growth number (microbial counts)
T0 and T1 = initial and final duration of fermentation
S = Substrate concentration
μmax = maximum specific growth rate
Ks = Monod constant
Ki = inhibition constant

The result showed that there was healthy utilization of the substrate for metabolite synthesis which serves as a factory of enzymes for biotechnology and bioprocessing. The oxalic acid produced increased the inhibition efficiency of corrosion which reduced the loss of metals (Chioma and Agwa 2018; Chioma et al., 2021).

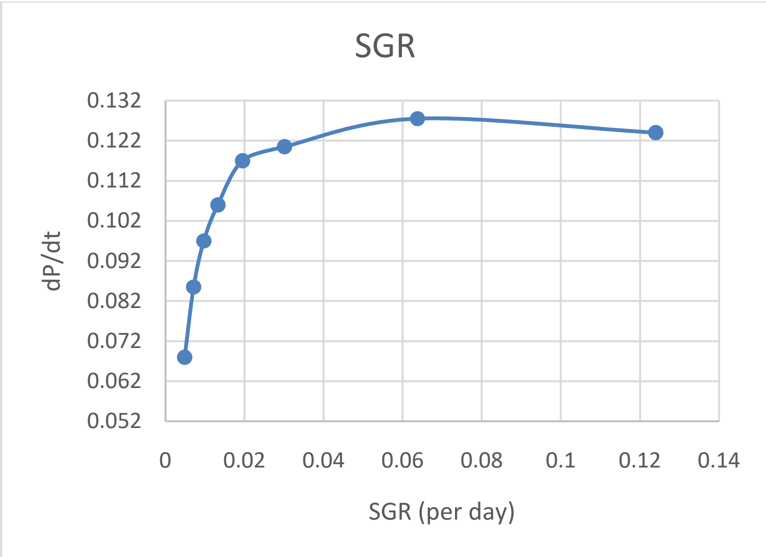


Fig. 10. Leudeking - Piret Plot of Specific Growth Rate for the yeast extract using Product formation rate and specific growth rate.

5. Itaconic, fumaric, pyruvic, gluconic, succinic and malic acids were produced by using wet cells of *Chlorella vulgaris* as a source of feedstock and some species of *Aspergillus*. They are widely used in food as an acidulant, in nanotechnology, as hardening agent and can be incorporated in the production of several biomaterials such as polymers.

III**. Bioplastics**: Plastics are employed in every field in life; they can be used for various purposes because they are inexpensive, light weight and durable. Due to increase in urbanization and industrialization has escalated the drive for plastic production. Unfortunately, due to its non –degradable nature, they build up in the environment causing serious harm to human health, wildlife and the environment. Thus, inspiring the search for an ecofriendly non–petrochemical environmentally acceptable alternative. Bioplastics are renewable, biodegradable resource which cause no environmental harm, are directly derived from microorganisms utilizing easily available nutrients.

Wet cells of *Chlorella vulgaris,* brewers spent grain, beans bran, fish meal, groundnut oil cake waste and roasted ground nut skin were used for production of microbial bioplastics. The substrates are easily available in Nigeria and may offer potential opportunity to reduce the cost of bioplastic production. The utilization of these cheap renewable resources as an alternative substrate in the production of industrial products and can serve as a sustainable venture for wealth creation. The biomass used in the research was a waste to wealth application potential offering a dual function as a value added agro-waste in waste management and cost-effective medium formulation for bioplastic production (Dienye et al., 2023).

IV. **Exopolysaccharides**: Microbial exopolysaccharide has gained acceptance as a fast high yielding sustainable polymetric substance that can be used as an alternative to synthetic polymer. These are essential metabolites synthesized and excreted by certain microorganisms in response to extreme conditions of pH, temperature, salinity, osmotic stress and other contaminants for survival in adverse environments.

Sweet potato peel and beans bran were used as a source of substrate in a cost-effective medium for the production of exopolysccharides. Results indicated that these agricultural wastes can be used as an inexpensive alternative route to synthesize exopolysaccharides from microorganisms (Nwosu et al., 2019, Nwankwo et l., 2024). They are used as biosorbent, binders, coagulants, emulsifiers, stabilizers, gelling gents, thickeners and viscosifiers in oil field activities.

V. **Surface active agents** (b**iosurfactants):** These are compounds produced with the potential of reducing surficial and interfacial tension that can be used in several industrial applications. Their activity is due to the presence of organic and inorganic moieties which acts as interfaces. They have been identified to possess varying antagonistic relationship to some microorganisms but can be synthesized by them for various purposes.

Locally sourced agrowastes such as cornchaff, yam peel, banana, cassava, potatoes and orange mesocarp with microorganisms isolated from palm oil impacted soils were used for the production of surface active agents. They are environmentally friendly, biodegradable, are stable and serves as an alternative to synthetic surface active agents due to its low toxicity. This finding indicates that the biorefinery and application of biomaterials such as sophorolipids has the potential to preserve and restore the ecological balance of polluted environments. The palm oil effluent can as well be used as a veritable tool in technological microbiology with the ease to handle non –toxic microbial products that can be used to create wealth and preserve the ecosystemas in Fig.11 (Effiong et al., 2019; Williams et al., 2021).

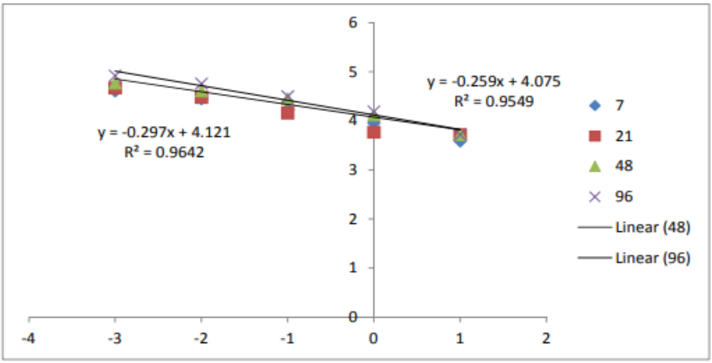


Fig. 11. Toxicity of *Saccharomyces cerevisiae* (Sophorolipid) against *Nitrobacter* sp.

CONCLUSION

Mr. Vice Chancellor Sir, permit me to say that microbial diversity is becoming an interesting issue in the world. In this lecture, Technological Microbiology has been used in various areas to produce useful biological products which plays vital role in the society. Surprisingly, these products have very low toxicity, are ecofriendly, cheap, readily available, is not competing with food crops or arable lands. Gradually, the society is advancing its economic system to the use of biological resources, moving from fossil fuel to bio-based products and renewable energy is the game changer. Thus, transforming waste to wealth, this transition will continue to address issues related to food security, health, industrial restructuring and energy security. This buttress the concept of waste management and its utilization for the production of useful biological products which is in line with United Nations Sustainable Development Goals (UNSDG) numbers seven and nine. Giving their critical role in aquaculture, human nutrition, pharmaceuticals and their demands for primary metabolites, they undeniably stand poised as a linchpin for future industrial innovations

FUTURE RESEARCH

We are trying to develop different models that would be able to enhance yield and productivity of microbial cell factories. Machine learning and algorithms are been investigated for genetic manipulation, development and improvement for industrial purposes and innovative strategies to address environmental and health related challenges. As well as integration of engineering concepts and automation to create an artificial metabolic pathway for producing novel products.

RECOMMENDATIONS

My recommendations based on this lecture is as follows

1. Identification of other strains of microalgae in the environment which will perform uniformly throughout the season and their genetic engineering for good biomass productivity.

2. Integration of waste- to – wealth technology that will enhance the processing and storage of agrowaste as feedstock for research and serve as repository for further studies in the area of technological microbiology. There is need to develop a culture and biomass collection center for commercial and industrial scale-up studies.

3. More research should be carried out on under-utilized or unutilized waste materials which can serve as renewable resource for bioenergy production which is a sustainable venture for wealth creation.

4. Funding is a critical challenge facing indigenous research which must be resolved so as encourage young researchers carry out indigenous research. The institution and government must engage investors on better way of sourcing and disbursing funds for research and in time to encourage production of reliable and verifiable results.

5. The government and other international agencies are encouraged to set-up a functional -knowledge economy center to improve research and consolidate on indigenous and

collaborative research such as the production of useful biological products using locally available biomass.

6. The ecological indices of the organically synthesized biological products as ecofriendly alternative to the conventional industrial products have been identified and can be used as a model for the development of process for organically synthesized metabolites.

7. There is the need for operators of oil field industries to synergize with institutions for the development of microbial-based tensioactive materials for various applications.

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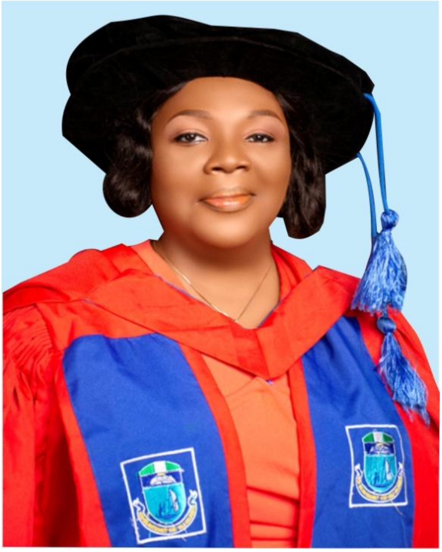
CITATION



Professor Obioma Kenechukwu Agwa

(*Professor of Environmental and Industrial Microbiology)*
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Obioma Kenechukwu Agwa (Nee Nkenke) was born on 3rd February, 1972 in Enugu, Enugu state, to Robinson Nweke Nkenke and Theresa Nwamazi Nkenke of Enugwu-ukwu in Anambra State. She is the last child amongst her siblings. She had her early education at Amaigbo Lane Primary School (Afternoon session) from 1977 -1983. Due to her outstanding performance in the National Common Entrance Examination, was posted to Queen's School Enugu for Secondary Education and obtained her Senior Schools Certificate Examination (SSCE) in 1989. She proceeded to Nnamdi Azikiwe University, Awka for her tertiary education. At Nnamdi Azikiwe University, she was very respectful, focused and resourceful which gave her the opportunity to become the 1st Female Departmental President of National Association of

Microbiology Students (NAMS) in 1993 - 1995. She graduated with a Second-Class Honour upper Degree in Applied Microbiology and Brewing Technology. She served with 7up Bottling Company Ogbor Hill, Aba as a Quality Control Assistant. As a result of her outstanding performance, the company wanted to retain her but she declined and proceeded for her Master's Degree in 1997. She performed creditably well and completed the program on time and bagged a Master's of Science Degree in Industrial Microbiology in 1999. She worked with several establishment and later gained employment with University of Port Harcourt where she enrolled for her Doctorate Programme and bagged the Doctor of Philosophy (PhD) in Industrial Microbiology and Algae Biotechnology in 2012 despite the challenges within the home front, research and her career.

Professor, Obioma Kenechukwu Agwa is dedicated and career oriented with specific objective in Algae Biotechnology by managing waste materials and its utilization for the production of useful biological products. She is determined to make useful contributions to humanity on pollution control by using renewable resources leading to sustainable development. Her research areas span in the area of microbial diversity, screening for novel products, industrial production of useful biological products and applicability of these products to the environment especially in oil field activities.

Within the University, she has served in various capacities, Member, Welfare committee, Department of Microbiology 2006, Member, Accreditation committee, Department of Microbiology, 2006, Chairman, Under graduate Project Committee, Department of Microbiology, 2013 -2019, In 2018, she won the award as the best biology tutor of basic studies unit, Member, Faculty of Science, Welfare Committee

2014 -2018, Secretary, Accreditation committee, Department of Microbiology 2016 - 2017, Secretary. Departmental Examination Malpractice Committee (DEMAC) 2018 - 2020, Member, Faculty of Science, Academic Ethics Committee, 2018 – 2020, Secretary, Faculty of Science, Book Review Committee, 2020 -2022, Member, Faculty of Science, Book Review Committee, 2023 - till date, Member, Degree Verification Committee, 2024 – till date, Welfare Chairman, Department of Microbiology, 2024 – till date.

She has published widely in her research areas with significant results and within the process has risen through the rank to become a Professor of Environmental and Industrial Microbiology in 2022. She has up to 70 published articles in Local and International peer reviewed Journals, several chapter contributions in edited books. She has a very good understanding with her mentees and collaborates effectively with all of them, thus leading to her success story in mentorship. Her research rose as a result of numerous supervisions up to 200 Students at Undergraduate level, 50 Students at Post graduate and has graduated up to 8 PhD; 30 MScs amongst others.

She is a member of Nigeria Society of Microbiology (NSM), Nigeria Association of Women in Science (NAWS), Society for Applied Microbiology (SFAM) and American Society for Microbiology (ASM).She is an active member of the Organization of Women in Science for the Developing World (OWSD) where she became one of the National Executives in 2017 as South-South Coordinator, after the election at the Benson Idahosa University where she was saddled with the task of reviving Uniport branch, a responsibility that was effectively carried out and the result is astonishing till date.

Prof. Obioma Kenechukwu Agwa, is devout Christian of Assemblies of God Church, a Deaconess and the Secretary of the Women's Ministries, Sunday School teacher, Sunday School Superintendent - Children Evangelistic Department, Secretary, Education board of Assemblies of God Church, Woji Town, Member, Northern Rivers District, Project Committee. An active member of her alma mater 'Queen's School Enugu' Port Harcourt branch where she is currently their treasurer and a member of the welfare committee.

She is happily married to Mr. Emmanuel Chukwuemeka Agwa and their marriage is blessed with five children.

Distinguished ladies and gentlemen, I present to you a humble, passionate teacher, mentor, motivator, strong, hardworking, dedicated, a woman of impeccable character and integrity, God fearing with a heart of gold, Prof. Obioma Kenechukwu Agwa as she presents her inaugural lecture titled ----WASTE TO WEALTH: THE TECHNOLOGICAL MICROBIOLOGY WAY

Prof. Owunari Abraham Georgewill
Vice Chancellor