

EXPLORING OPPORTUNITIES IN MARINE BIOTECHNOLOGY FOR YOUTH UNEMPLOYMENT IN NIGERIA

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Abstract

Nigeria faces a persistent youth unemployment crisis, with over 40% of young people either unemployed or underemployed. This study examines the potential of marine biotechnology as a pathway for youth employment generation. Using a systematic literature review of 35 relevant sources, the study identifies marine biotechnology activities and their potential to generate jobs for Nigerian youth. Findings indicate significant opportunities across research, production, and marketing of marine bioproducts, including pharmaceuticals, nutraceuticals, biofuels, and cosmetics. The study concludes that targeted policy interventions, youth training, and investment in marine biotechnology could reduce youth unemployment while contributing to Nigeria's blue economy. Nigeria is grappling with a persistent youth unemployment crisis, with over 40% of young people either unemployed or underemployed. This paper explores the potential of marine biotechnology as viable pathway for youth employment generation in Nigeria. The study applies a systematic literature review of 35 relevant documents to examine marine biotechnology activities and the potential of marine biotechnology for youth unemployment. By assessing the opportunities in this sector, the study highlights its potential for youth unemployment in Nigeria. The key findings reflect enormous opportunities like employment opportunities, in marine biotechnology. The paper concludes by emphasizing the need for targeted and sustained efforts to enlighten the youths on the untapped potential of marine biotechnology in Nigeria

Keywords: Blue Economy, Marine Biotechnology, Youth, Unemployment

1. Introduction

Youth unemployment remains a major socio-economic challenge in Nigeria, with over 35% of young people between the ages of 15 and 34 unemployed and an additional 28% underemployed (Federal Ministry of Youth Development, 2022;

UNDESA, 2022). The country's demographic youth bulge, coupled with limited high-value employment opportunities, exacerbates this challenge. Globally, countries such as Bangladesh and Canada have leveraged the blue economy—the sustainable use of ocean resources for

economic growth, improved livelihoods, and jobs—to reduce youth unemployment (Shamsuzzaman et al., 2020; Mozumder et al., 2023b; Voyer et al., 2018).

Although youth unemployment is a worldwide problem that has a major impact not only Nigeria but the developing nations. This is one of the challenges of our time (Ahmad & Imran, 2024). In response, numerous countries have started using oceanic natural resources to help alleviate this issue (Wordu & Wodi, 2024). In nations like Bangladesh and Canada, the rise of the blue economy has been significant in lowering unemployment rates (Shamsuzzaman et al., 2020; Mozumder et al., 2023b; Voyer et al., 2018). Any economic activity that is either directly or indirectly related to seas, oceans, and coastal areas is included in the blue economy (Purcell, 2023). Marine biotechnology, seabed mining, marine renewable energy, coastal tourism, fisheries and aquaculture, and maritime transportation are important industries (The Commonwealth, 2023).

The fields of fishing, maritime transportation, tourism, renewable energy, and seabed mining have all been extensively studied in the literature (Hasan, 2024; Mondal, Abit, Siddiqui & Al-Asif, 2024), but marine biotechnology has received very little attention, especially in the Nigerian setting. Even though Nigeria's coastal states like Lagos, Rivers, Bayelsa, Cross River, Ondo, and Delta have abundant marine resources, little scientific study has been

done on how marine biotechnology might be used to combat youth unemployment. Nigeria's demographic youth bulge; 33% of the population is between the ages of 15 and 24 exacerbates the country's acute youth unemployment situation (UNDESA, 2022). In addition, it is projected that 66 million people will join the workforce by 2030 (Price, 2019).

Currently, 28% of Nigerian youth between the ages of 15 and 34 are considered underemployed, and 35% are unemployed (Federal Ministry of Youth Development, 2022).

The blue economy includes sectors such as fisheries, coastal tourism, maritime transportation, renewable marine energy, seabed mining, and marine biotechnology (Purcell, 2023; The Commonwealth, 2023). While fisheries, tourism, and renewable energy have been extensively studied (Hasan, 2024; Mondal et al., 2024), marine biotechnology remains underexplored, particularly in the Nigerian context. Nigeria's coastal states, including Lagos, Rivers, Bayelsa, Cross River, Ondo, and Delta, possess abundant marine resources that can support marine biotechnology activities (Price, 2019).

This study focuses on how marine biotechnology can contribute to youth employment in Nigeria, exploring untapped opportunities within the sector.

1.2 Statement of the Problem

Youth unemployment in Nigeria has persisted for decades, with 35% of youths unemployed and 28% underemployed (Federal Ministry of Youth Development, 2022). Various sectors of the economy, including agriculture, communication, and select blue economy sectors such as fisheries and marine renewable energy, have been identified as potential drivers of youth employment (World Bank, 2019; Adesina et al., 2022; IRENA, 2021). However, marine biotechnology—a high-value, knowledge-intensive sector—has received minimal attention.

Youth unemployment has been on the rise for many years in Nigeria. Statistics revealed that 35% of Nigerian youths between the ages of 15 and 34 are unemployed and 28% are considered underemployed (Federal Ministry of Youth Development, 2022). Several sectors of the economy including agriculture, communication and other fields of blue economy including seabed mining, marine renewable energy, coastal tourism, fisheries and aquaculture, and maritime transportation have been identified to have the needed capacity to tackle this issue in Nigeria (World Bank, 2019; Adesina et al., 2022; IRENA, 2021). Despite the marine resources available in Nigerian coastal states like Lagos, Rivers, Bayelsa, Cross River, Ondo, and Delta, no literature has been identified to address how marine biotechnology impact on youth unemployment. Additionally, few existing literatures on marine biotechnology

focused on its application (Nnodim, 2024), marine bacteria bioproducts (Maldonado-Ruiz, Pedroza-Islas & Pedraza-Segura, 2024) and so on, which limits a holistic understanding of opportunities in this sector.

Existing studies on marine biotechnology in Nigeria focus mainly on isolated applications, such as bacterial bioproducts or pharmaceutical developments (Nnodim, 2024; Maldonado-Ruiz et al., 2024), limiting comprehensive understanding of employment opportunities. Furthermore, there is limited empirical research on the potential of marine biotechnology to generate jobs for Nigerian youth, highlighting a critical gap that this study seeks to address.

2. Review of Literature

1.2 Research Questions

1. What marine biotechnology activities exist in Nigeria that could generate youth employment?
2. What is the potential of these activities to create jobs for Nigerian youth?

1.3 Research Objectives

1. To identify marine biotechnology activities that could create jobs for Nigerian youth.
2. To evaluate the employment potential of these activities in Nigeria.

2.1 Conceptual Review

The blue economy encompasses all economic activities that are directly or indirectly linked to oceans, seas, and coastal

areas, emphasizing sustainability and innovation while addressing environmental challenges (Purcell, 2023). A key component of the blue economy is marine biotechnology, which applies scientific and technological processes to marine organisms and resources to develop products and applications with industrial, health, and environmental relevance (Cristina, 2022; Gbadegesin & Akintola, 2021).

Marine biotechnology activities include research and development, bioharvesting, bioprocessing, bioprospecting, bioremediation, and production of bioproducts such as pharmaceuticals, nutraceuticals, cosmetics, biofuels, and biomaterials (Hussain et al., 2018; OECD, 2021). By leveraging marine biodiversity, the sector can generate employment opportunities across research, production, marketing, and entrepreneurship.

Purcell (2023) asserts that the blue economy encompasses all economic activities directly or indirectly related to oceans, seas, and coastal areas. She emphasizes that it involves innovative and sustainable strategies, solutions and technologies aimed at addressing environmental challenges while promoting economic development and responsibility harnessing ocean resources. A key component of the blue economy is marine biotechnology.

The use of biotechnology on marine resources is referred to as marine

biotechnology. It is a developing field centred on the utilisation of marine natural resources. All endeavours that use marine resources as a source or a target for biotechnology applications fall under the umbrella of marine biotechnology (Cristina, 2022). Marine biotechnology encompasses research and development activities that leverage marine organisms to create innovative products in fields such as pharmaceuticals, cosmetics, and nutritional supplements (Gbadegesin & Akintola, 2021). This emerging sector holds significant potential for job creation across various domains, including research, production, and marketing (OECD, 2021). In order to change living or non-living materials for the development of knowledge, goods, and services, biotechnology involves applying science and technology to live creatures as well as their components, products, and models. The live organisms used in marine biotechnology come from aquatic sources (Hussain et al., 2018). Applications for marine biotechnology may include: health, food, cosmetics, aquaculture & agriculture, fisheries, manufacturing, environmental remediation, biofilms and corrosion, biomaterials, research tools, etc. Marine biotechnology may include techniques such as bioprocessing, bioharvesting, bioprospecting, bioremediation, using bioreactors, etc. (so-called process biotechnology techniques).

2.2 Theoretical Framework

Theoretical Framework

This study is grounded in Youth Empowerment Theory (Zimmerman, 1995, 2000; Sazama & Young, 2006; Reischl et al., 2011), which emphasizes processes that enhance youth participation, decision-making, and skill development. The theory posits that engaging youth in meaningful, community-centered activities fosters skills, confidence, and responsibility. Marine biotechnology, as a knowledge- and technology-driven sector, offers opportunities for youth empowerment through skill acquisition, entrepreneurship, and employment creation.

The study also, utilizes youth empowerment theory which emphasizes processes that promote active participation, enhance decision-making through shared control, and create opportunities for learning, practicing and developing skills. Initially introduced by Zimmerman (1995) and further expanded in Zimmerman's later work (2000), the theory was subsequently refined by scholars such as Sazama and Young (2006) and Reischl et al., (2011). According to this framework, youth empowerment and entrepreneurial development are driven by a series of actions that encourage young people to engage in entrepreneurial activities, take greater control over decisions affecting them, and access opportunities to enhance their competencies. The theory posits that when youth are involved in prosocial, meaningful, and community-centered

activities, particularly those they help define and manage, they acquire essential skills, develop a sense of responsibility, and build the confidence necessary to become capable, healthy and productive adults.

2.3 Empirical Review

Empirical Review

A review of existing literature highlights the potential of the blue economy for job creation: Nigeria: Akinwumi (2020) shows that fisheries and aquaculture in the blue economy can generate employment. Hamisu (2019) emphasizes the importance of policy frameworks for sustainable ocean management. Nsa et al. (2025) and Nweke & Ali (2025) highlight economic diversification opportunities but note that marine biotechnology is underexplored.

Global Context: Amarh (2017) analyzed Ghana's blue economy, noting opportunities in employment and innovation while highlighting challenges such as pollution. In Kenya, Lee et al. (2020) reported the creation of over 1,700 jobs in bioethanol, biogas, and electric cooking sectors, illustrating the potential of bio-based ocean industries.

These studies underscore the gap in Nigeria regarding marine biotechnology employment opportunities, justifying the need for focused research. Akinwumi (2020) investigated the impact of Blue Economy and Job Creation in Nigeria. Using a vector autoregressive model, reveals that the blue economy can create jobs in Nigeria, particularly in the areas of fisheries and

aquaculture. From the findings he recommends that the government should invest in infrastructure and create policies to support the development of the blue economy sector. Hamisu (2019) conducted desktop research on Nigeria's blue economy potential, focusing on oil and gas. The study found that growing ocean pressures have led to increased policy attention and the development of governance frameworks for sustainable ocean management. Amarah (2017) examined Ghana's blue economy through document review and interviews with key stakeholders. The study highlighted the blue economy's importance for national development while noting challenges like pollution from illegal mining and scientific fishing.

3. Methodology

The research adopted a systematic literature review in which a search process was utilised to find relevant research associated with the research domain. Following an extensive review using search engines and databases such as IEEE,

Scopus, PubMed, Web of Science, and Google Scholar to identify relevant articles and books on the research topic, an initial list of preliminary keywords was selected to provide a suitable and focused perspective for addressing the research questions. The selected keywords such as “Blue Economy” “Marine Biotechnology,” “Youth,” “Unemployment,” were included to cover the research literature comprehensively. Five main steps were followed in conducting the critical review. These steps included conducting an online database search using relevant keywords across platforms such as IEEE, Scopus, PubMed, Web of Science, and Google Scholar; an initial refinement based on selection criteria including the title, abstract, and keywords; a second refinement based on additional attributes such as publication year, access type, and document type; a third-level refinement focusing on the main topic through abstract screening and a full-text review of the selected articles. The refinement process, along with the number of resources retained at each stage, is illustrated in Figure 1.

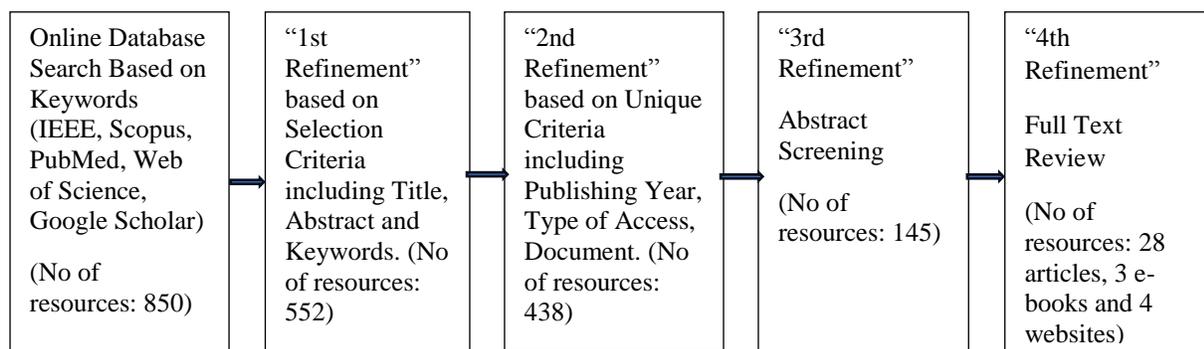


Fig. 1: Refinement Procedures
Source: Researcher’s Computation, 2025

3. Exploration of Marine Biotechnology

At the end of the search and after several stages of filtering, 28 related articles, 3 e- books and 4 official websites of

international organizations were found that were wholly focused on marine biotechnology. The literature concerning the main research is divided into 2 categories as shown in Figure 2.

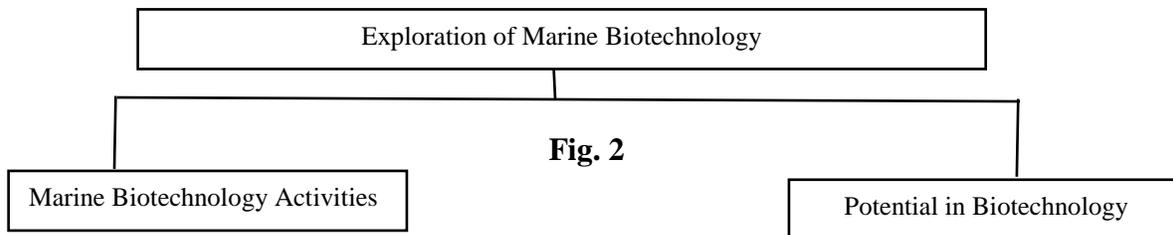


Fig. 2

Source: Researcher’s Computation, 2025

The first category focuses on the marine biotechnology activities in blue economy while the second category reveals the potential in marine biotechnology.

4.1 Marine Biotechnology Activities

Marine biotechnology involves harnessing marine resources to develop products and applications with industrial relevance. It encompasses research and development activities that leverage marine organisms to create innovative products in fields such as pharmaceuticals, cosmetics, and nutritional supplements (Gbadegesin & Akintola, 2021). This emerging sector holds significant potential for job creation across various domains, including research, production, and marketing (OECD, 2021). Given the ocean’s vast biodiversity, this field holds immense potential to benefit a wide range of sectors. One notable example is the development of wound dressings coated with chitosan: a sugar typically

derived from the shells of shrimp and crabs known for its biocompatible and properties.

4.2 Potential in Marine Biotechnology

Marine resources hold immense potential for the development of new biotechnology products, ranging from pharmaceuticals and cosmetics to food supplements. This sector not only drives innovation but also fosters job creation in areas such as research and development, production and marketing (OECD, 2021). The ocean is a source of genetic materials useful in medicine, cosmetics, and agriculture. Marine bioprospecting can lead to discoveries of new drugs and bio-products. Encouraging investments in marine research institutions and partnerships with global biotech can position Nigeria as a center for marine biotechnology in West Africa (World Bank, 2020). Marine biotechnology contributes to the bioeconomy by creating jobs throughout the

value chain from academic positions to positions in industry. In this sector, the rise in marine-related patents as a proportion of all patents related to drug development can be used as an indicator of the increasing contribution of marine biotechnology. This output, linked to marine biotechnology R&D inputs such as funding, may provide a partial picture of the economic impact of marine biotechnology. However, a more complete picture will be required both for this sector and for others. Pharmaceuticals and nutraceuticals are extracted from marine organisms for medicinal or health-related purposes. Several pharmaceutical products like agar and carrageenan, vitamins A and D are derived from fish liver oil, while polyunsaturated fatty acids like eicosapentaenoic acid and docosahexaenoic acid are also gotten from marine organisms (Francesch et al., 2024). Biofuel production using algae or other aquatic biomass for biofuel production. Microalgae are good sources of biofuel production because of its relatively high oil content and rapid growth however, its cultivation in commercial quantity is hindered by difficulty in maintaining desirable species, low yield of algal oil and high cost of harvesting (Mohanta, 2021). Cosmetics are made from marine ingredients. Marine ecosystems harbor a rich diversity of organisms that

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habours marine collagen such as jellyfish, sponge collagen (spongin), and fish collagen, as a key component in skin rejuvenation (Makgobole et al., 2024)

5. Conclusion

Marine biotechnology holds tremendous potential as a sustainable solution to the youth unemployment crisis, offering a vast job creation opportunity. Studies indicate that in 2019, Kenya had approximately 700 full-time equivalent (FTE) jobs in the bioethanol sector, 800 jobs in the biogas sector, and 200 jobs in the electric cooking sector (Lee et al., 2020). The study concludes by emphasizing the need for targeted and sustained efforts to enlighten the youths on the untapped potential in marine biotechnology to reduce youth unemployment in Nigeria. Marine biotechnology can contribute to the bioeconomy through the development of innovative products and services in sectors such as food, health and manufacturing and through job creation. To the extent that marine biotechnology can contribute to the sustainable use of ocean bioresources, it can help to preserve the non-market value of the ocean and associated socioeconomic benefits (e.g. recreation, cultural traditions, tourism).

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