EXPLORING THE POTENTIALS OF MARINE BIOTECHNOLOGY FOR POVERTY ERADICATION AND NATIONAL DEVELOPMENT

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Abstract

Nigeria is a country that is endowed with huge natural resources. In spite of these endowments, the social well being of a large percentage of the citizens is characterized by clear signs of poverty and under development. The marine environment is rich in biodiversity with novel species of micro and macro organisms which could serve as a source for variety of new products. These products if tapped and commercialized can be good sources of revenue generation and in turn will promote the country's development and improve living conditions of the people. This paper sought to explain that exploring the potentials of marine biotechnology can make an increasingly important contribution towards meeting these societal challenges and in supporting economic recovery and growth. The challenges facing marine biotechnology were discussed. It is recommended that specific education and training initiatives should be provided to citizens at various levels of education.

Keywords: Biotechnology, marine, poverty eradication, national development.

In the context of a global economic downturn, some developed countries like (European countries) are now facing complex and difficult challenges such as the sustainable supply of food and energy, climatic change and environmental degradation, human health and aging population. In Nigeria today, the increasing rate of poverty, and so many other social problems such as unemployment and underdevelopment have become terrible issues to the government and to every well meaning citizen. Marine biotechnology can make an increasingly important contribution towards meeting these societal challenges and in supporting economic recovery and growth by delivering new knowledge, products and services.

There is a growing recognition of the ocean's biotechnological potentials, with the global market currently estimated at US$ 2.4 billion and with the annual growth predicted at 10 % (Allen and Jaspars, 2009). The European Commission describes it as "one of the most exciting technology sectors", and the Institute of Marine Engineering, Science and Technology (IMAREST) describes the sea as a "biotechnological frontier waiting to be explored" with "potential for marine biotechnological products to be used as anticancer agents, for bulk chemicals such as adhesives, for feed additives for aquaculture, and for remediation of environmental damage".

Biotechnology, the application of biological knowledge and cutting-edge techniques to develop products and other benefits for humans, is of growing importance for developing country like Nigeria. This will increasingly contribute to shape the future of our societies. Marine biotechnology, which involves marine bioresources, either as the source or the target of biotechnology applications, is fast becoming an important component of the global biotechnology sector.

The marine environment is a rich source of both biological and chemical diversity. This diversity has been the source of unique chemical compounds with the potential for industrial development as pharmaceuticals, cosmetics, nutritional supplements, molecular probes, enzymes, fine chemicals and agrochemicals. Each of these classes of marine bioproducts has a potential multi-billion dollar market value (Allen and Jaspars, 2009). Exploring the potentials of marine biotechnology can be a way forward in solving some of the societal challenges in the areas of food and energy security, poverty and underdevelopment.
Concept of Biotechnology

Biotechnology can be defined as the application of living organism, system or process to develop a commercial product or services. (Thakur and Thakur, 2006). Biotechnology is also the application of biological knowledge and cutting-edge techniques to develop products and other benefits for human (Colwell, 2002). It can also be said to be a process of using living organisms (such as plants, animals or microbes) or any part of these organisms to create new or improved products (Baiyeri and Aba, 2012).

The concept of biotechnology encompasses a wide range of procedure for modifying living organisms according to human purposes – going back to domestication of animals, cultivation of plants, and improvements through breeding programmes that employ artificial selection and hybridization.

Biotechnology can be applied in four major segments; biomedical, agricultural, industrial and environmental. Among these, the biomedical segment is growing very rapidly. Recombinant human insulin, novel pharmaceutical drugs, different vaccines, etc are some of the important examples of this success. In the field of agriculture, introduction of genetically engineered tomatoes, soybeans, cotton, etc show the impact of biotechnology. On the industrial and environmental fronts also, there is a tremendous progress.

Furthermore, the science of biotechnology can also been broken down into subdisciplines called red, white, green and blue biotechnology (Nwankwo, Peters and Bokemann, 2009). Red biotechnology involves medical processes such as using organisms to produce new drugs or using stem cells to regenerate damaged human tissues and perhaps re-grow entire organs. White (also called grey) biotechnology involves industrial processes such as the production of new chemicals or the development of new fuels for vehicles. Green biotechnology applies to agriculture and involves such processes as the development of pest-resistance grains or the accelerated evolution of disease resistant animals. Blue biotechnology encompasses activities in the marine and aquatic environments, such as controlling the proliferation of obnoxious water borne organisms.

Marine Biotechnology

Marine biotechnology can be broadly defined as the technology that uses living marine organisms, or their parts, to make or modify products (indrani, 2000). Marine biotechnology is defined as the application of scientific and engineering principles to the processing of materials by marine biological agents to provide goods and services (Zilinskas et al 1995).

Marine biotechnology explores the oceans to develop novel pharmaceutical drugs, chemical products, enzymes, and other industrial products and processes. It also plays a vital role in the advancement of biomaterials, health care diagnostics, aquaculture and seafood safety, bioremediation, and biofouling. The population and human needs continue to increase, obviously the pressure on natural resources will also continue to grow. To meet these growing needs, we can turn towards marine environment, which occupies one-third portion of our planet.

The Potentials of Marine Biotechnology in Poverty Eradication and National Development

Marine sustainable aquaculture and fisheries

Aquaculture could be defined as farming of fish (cat fish, tilapia), mollusks (shrimps, prawn), crustaceans (bivalve) or aquatic plants in which there is an intentional intervention in the process of rearing these organisms with the sole aim of enhancing production yield, and high nutritional values. Fish and fisheries products provide protein and essential micronutrients for balanced nutrition and health (FAO, 2012). Among the 40% of the world inhabitants living along the coastline of the oceans, fishing serves as source of income to most of them. Most developing countries only practice small scale fisheries out of over 40 million people globally earning income from aquaculture. One of the ways to reduce many demands on fisheries stock and yet still meet worldwide demand for seafood is through sustainable aquaculture as world demands could lead to complete collapse of the fishery industry (Worm et al., 2006).
b. Sustainable alternative source of energy

The ocean is an untapped, sustainable source of bio-energy. There are many examples of the production of bio-energy from marine organisms, but the production of biofuel from microalgae presents perhaps the most promising option to harvest this huge energy potential. The discovery of crude oil was a fundamental scientific breakthrough due to products like petroleum, diesel, lubricating oil, gasoline and others that were derivable from its raw form. Various countries of the world like Nigeria have relied solely on crude oil as a major economy booster. Some of these products like petrol, kerosene and gas are becoming more expensive and unaffordable to citizens of developing countries. Marine microalgae or phytoplankton have been targeted as good renewable energy source (Walker et al., 2005). Exploring these resources can go a long way in solving these problems.

c. Human Health

Most of our medicines come from natural resources and scientists are still exploring the organisms of tropical rain forest for potentially valuable medical products. More than 2000 years ago, the extracts of marine organisms had been used as medicine. Take for instance, in the 19th and early 20th centuries, Cold-liver oil was in use as supplementary nourishment (Thakur, and Thakur, 2006). However, only in the middle of 20th century, scientists began to systematically probe oceans for medicines (Thakur, and Thakur, 2006). Most of these drugs especially the antibiotics are very expensive and scarce; nevertheless, the seas and oceans represent a huge potential source of new drugs, innovative treatments and diagnostic tools for human health (Torger et al., 2010). Interestingly, these natural products have been obtained from marine microorganisms as well as invertebrates such as sponges, mollusk, bryozoans, tunicates etc (Thakur and Muller, 2004).

d. Biomaterial and Bioprocessing from Industry

Marine organisms synthesize chemicals with bioactive properties, such as metabolities, proteins, enzymes, polysaccharides and lipids, which have lead to new processes. These contribute significantly to industrial biotechnology and can also support novel process development in the food and pharmaceutical industries or in molecular biology and diagnostic kits (Torger et al., 2010). For example, the luminescent properties of the jellyfish Aequorea Victoria led to the characterization of the green fluorescent protein (GFP). A natural “soap” (biosurfactant), produced by oil-eating marine bacterium, (http://www.biotechinstitute.org/pdf).

e. Marine Microbial Enzymes

Microorganisms from the marine environment has received much research attention from scientists because enzymes produced by these organisms are found to be more potent biochemical and stable than those derived from plants and animals (Kin, 2006). Advancement in biotechnology globally has led to increased interest and search for enzymes with unique properties. It is however from marine environment that such enzyme could be obtained as a result of the complex nature of the marine ecosystem due to low temperature, high salinity and pressure because these microorganisms require enzymes different from those obtained from other forms of live to be able to survive in these type of environment. So far, enzymes obtained from marine microbial sources have been used in food additives, pharmaceuticals and other chemicals substances. Protease is the most commercially available enzymes with over 60% of world enzymes. These enzymes are used in leather and detergent industries respectively.

f. Environmental Biotechnology

Degradation of hazardous material is an important issue worldwide. Marine biotechnology is playing an increasingly important role in the protection and management of the marine environment.
It has been found that marine microorganisms express novel biodegradation pathways for breaking down a variety of organic pollutants. Marine microorganism also, frequently produces eco-friendly chemicals, such as biopolymers and biosurfactant that can also be applied in environmental waste management and treatment.

Biofouling refers to the assemblage of marine organisms on man-made structures and devices submerged in the sea. It causes deterioration and heavy economic penalties to marine industries (Thakur and Thakur, 2006). Several attempts are made to control biofouling with the application of physical, chemical and biological measures but results, to the greatest extent, are achieved with the use of antifouling paint coatings (Thakur and Thakur, 2006).

g. Marine derived functional foods

Functional food can be defined as foods having resemblance to “normal”, conventional foods in terms of appearance which are therefore consumed like other foods although with inherent health enhancement and reduction of risk of diseases potentials (Odeyemi, 2013). In 2010, Kadam stated that marine ecosystems are good sources of high valued functional foods because they are naturally rich in functional ingredients like algal constituents, carotenoids, omega-3 oils, fish protein hydrolysates, chitin, chitosan, collagen and taurine. These functional ingredients can be extracted from the marine sources and incorporated into conventional foods to achieve the purpose of health enhancement. Marine bacteria, fungi, algae, macro and microalgae are excellent sources of functional ingredients.

Challenges of Marine Biotechnology

There are certain challenges or barrier to efficient exploitation of marine resources. In spite of the increasing attention on the part of molecular scientists and industry on the potential development of marine biotechnology, there are no coherent guidelines, framework conventions, guiding norms or principles to specially govern the conduct of marine biotechnology development neither in the United States nor in other countries (Knecht et al., 2001). Factors such as

- lack of adequate man power in the field,
- poor infrastructures,
- state of the art equipment,
- research funding from government agencies, and
- adequate awareness and policy ,are some of the challenges facing marine biotechnology.

Conclusion

Exploring potentials of marine biotechnology in developing countries could help solve problems of food shortage, poverty, unemployment, disease outbreak by discovering novel bioactive compounds needed to combat resistant pathogens. Underdeveloped country like Nigeria can also move ahead and meet up with the global challenges.

Recommendations

For potentials of marine biotechnology to be completely tapped, the following need to be done;

1. Developing countries need to consciously empower its citizens through inclusion of marine science related courses into their post secondary and higher education curricula.
2. More scientists need to be sponsored either through private or public scholarships and trained in developed countries that are well advanced in exploring marine biotechnological world on the use of various molecular marine biotechnology tools that are needed to further their knowledge in the field.
3. Conference, seminar and workshops on benefits of marine related researchers should be organized nationwide.
4. More marine research stations or institutes should be located in all states of the countries, this will help to foster marine research.
Large-scale facility funding may be very effective, making industry aware of new biotechniques and sources of innovation can be powerful, provided these are relevant to their products and processes, and important for their survival.

Effective academic-Industrial collaboration is essential to bring any novel marine biotechnological outputs to the market.

References


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