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Mini Review

Marine Biotechnology's in the Blue Economy

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Abstract

A more modern technology that supports and enhances the growth of the blue economy is marine biotechnology. Marine biotechnology is more of a discipline that draws its biological applications from marine bioresources. Over the past few decades, the market-related use of marine resource biotechnology has gradually increased. By 2020, the market for many marketed items will have grown to several billion USD annually, with a 4-5% average annual growth rate. Polyunsaturated fatty acids (PUFAs), microbiomes, and coatings are potential biotechnology uses in marine settings. The market for blue biotechnology has expanded significantly in the Asia-Pacific region, while the European region has seen its growth accelerated by the increasing emphasis on marine technology for the study and development of novel drugs. However, blue biotechnology is still relatively underutilised in many fields. The market in this area is slowed down by a lack of knowledge about the use of marine microorganisms and their applications (Bethel BJ et al., 2021).

Keywords: Marine biotechnology, Blue biotechnology, Marine bioprospecting, Blue economy, marine bioresources, Substantial growth, Sustainable development goals, Genome, Microbiome

INTRODUCTION

The use of biotechnology technologies on marine resources is referred to as marine (or blue) biotechnology. All endeavours that use marine resources as a source or a target for biotechnology applications fall under the umbrella of marine biotechnology. 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 MG et al., 2018). Marine biotechnology is a developing field centred on the utilisation of marine natural resources. Biotechnology is defined as the industrial application of live organisms or biological procedures created via fundamental research. Since creatures may be found throughout the water column, the oceans, which make up around 71% of our planet's surface, also represent the biggest temperature, light, and pressure fluctuations that life has ever experienced. A vast marine bio- and genetic variety has resulted from adaptation to these challenging circumstances, with potential biotechnological uses for drug discovery, environmental cleanup, improving the availability and safety of seafood, and creating new resources and industrial processes (Choudhary P et al., 2021).

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). As a result, the horizontal breadth of marine biotechnology encompasses a wide range of uses, many of which rely on the marine environment for their raw materials. This includes creating a cutting-edge buoy system for monitoring ocean pollution to generating a novel cancer therapy from a deep-sea sponge. Similar to the larger subject of biotechnology, marine biotechnology (also known as MBT) may take both high-tech and extremely conventional forms, such as regional seaweed farming. For instance, the whole arsenal of genetic technologies is now being used to achieve objectives like pinpointing the specific mechanism by which a promising medication originating from a marine creature kills cancer cells. Bio-prospecting, enhancing the productivity of marine creatures, creating innovative goods, notably food and feed items, as well as developing diagnostics and biosensors are a few examples of marine biotechnology's commercial uses (Hussain MG et al., 2017). The whole drug/molecule development process, including screening, identification, efficacy testing, safety testing, and large-scale commercial manufacturing, is included in bioprospecting. Secondary metabolites generated by marine creatures are known as bioactive natural products. Over the past two decades, these products have drawn more chemists' and pharmacologists' attention. These compounds have been used for a wide range of things, such as food, pharmaceuticals, scents, pigments, and pesticides. The use of these products in drug development has recently increased significantly thanks to better biological screening methods. These goods display an intriguing range of unique and diverse chemical structures with powerful biological activity (Attri VN 2016).

One of the most exciting and well-known results of marine biotechnology research is drug development. Because they differ greatly from those generated by closely similar terrestrial animals, the biochemicals produced by marine invertebrates, algae, and bacteria have enormous promise as new classes of drugs. A neurotoxin from a snail that has painkilling properties and is 10,000 times more potent than morphine without the side effects is an example of a marine-derived drug. Other examples include an antibiotic from a fungus, two chemically related substances from a sponge that treat cancer and the herpes virus, and an antibiotic from a fungus. As more researchers turn to the sea for these biotechnological purposes, there are now a number of marine-derived substances in clinical trials, and it is anticipated that many more will move to the clinic. In addition to creating new medications, marine-derived substances are also used in cosmetics (compounds from algae, crustaceans, and sea fans), nutritional supplements (compounds from algae and fish), artificial bone (corals), and industrial applications (fluorescent compounds from jellyfish, novel glues from mussels, and heat resistant enzymes from deep-sea bacteria). Many chemicals thought to be suitable for therapeutic use have been found as a result of research into the pharmacological characteristics of marine natural products. Bioprospecting in the ocean holds immense promise, and interest in marine-based natural products is only beginning to grow. The likelihood of discovering natural compounds with unheard-of carbon skeletons and intriguing biological activity today is highest in marine sources. There are still many opportunities for study addressing novel habitats, such as deep ocean samples and symbiotic systems (Karani P et al., 2020).

Numerous ecological services offered by marine ecosystems have positive social effects. The majority of these services are connected to provisioning services (like food) and cultural services, such as tourism, as well as supporting services (like primary production and nutrient cycling). The application of marine biotechnology, in which marine organisms and their compounds are identified, extracted, isolated, characterised, and used for applications in various sectors to benefit society, ranging from food/feed to pharmaceutical and biomedical industries, has been made easier by recent advances in science and technology. Wide environmental gradients in physical, chemical, and hydrological factors including temperature, light intensity, salinity, and pressure contribute to the diversity of life in marine habitats. Marine creatures have developed a wide range of shapes, roles, and methods in response to these many settings, which are essential for their survival, adaptability, and success in the many of these competing ecosystems. The creation of biomolecules (secondary metabolites, enzymes, and biopolymers) is one of the evolutionary features of living marine phyla that are most encouraging for biotechnology. Biomolecules are fundamental in many other life-sustaining processes, mediating chemical communication between organisms, acting as a barrier against harmful environmental conditions, serving as weapons for catching prey or for protection against predators, pathogens, extreme temperature, or harmful UV radiation. Biomolecules are often capable of exerting biological action even at low concentrations to overcome dilution/dispersion effects happening in the water. Biomolecules have developed to increase the organisms' performance in their marine environments. Many marine metabolites have distinctive and intricate structures that make it possible to find novel and creative uses with a commercial angle. The percentage of medications that are now in use that come from natural substances is above 50%, and it is significantly greater for anticancer and antibacterial therapy agents. The removal and degradation of certain chemical compounds or organic materials as well as the creation of complex biochemical processes are some additional traits and functions of marine creatures that can be advantageous and of interest to a variety of businesses. Marine resources are still generally untapped and undervalued, nevertheless (Hoerterer C et al., 2020).

Marine bioprospecting

High-throughput screening is being done for new chemicals, particularly medicines (other uses includes in foodstuffs, nutraceuticals, adhesives, paints, cosmetics, environmental remediation, research etc). The whole drug/molecule development process, such as screening, identification, efficacy testing, safety testing, and large-scale commercial manufacturing, requires the application of biotechnology. It used to take anything between 10 and 20 years and up to $800 million for every one of the 10,000–20,000 compounds isolated from terrestrial microorganisms, plants, or animals to make it to market.12,13 Large pharmaceutical companies have stopped looking for novel medicines made from natural ingredients as a result. The fact that there aren't many pharmaceutical businesses in the pipeline is proof that this procedure is complicated. In contrast, given the high variety, paucity of existing knowledge, and harsh settings, marine biota provide a better chance of running onto effective candidates. The medications Ara-C and Ara-A, which are believed to be worth $50 to $100 million annually, were created from sponges in the early 1950s and quickly became popular. The projected annual market value of anti-cancer substances derived from marine creatures is $1 billion. Another excellent illustration is Vent-DNA polymerase, which is a fundamental component of Polymerase Chain Reactions (PCR). All animal and plant phyla dwelling in shallow and deep bottom environments are subject to bioprospecting. Less technological complexity and higher economic viability are two benefits of the first, while a wider and maybe more intriguing natural resource base is an advantage of the second. In general, it is believed that microbial and marine organisms are more likely than terrestrial ones to have novel species and compounds that might be beneficial in pharmacology discovered (Bir J et al., 2020).

Marine bioprospecting initiatives in the near future will probably concentrate on the potential for biotechnology to harness the knowledge contained in the genomes of these creatures, in addition to natural products derived from ocean plants, animals, and microorganisms. With the skills and technology that were developed after the Human Genome Project, scientists are now sequencing an expanding number of non-human genomes. A few marine bacteria have had their whole genomes sequenced, and work has been begun on sequencing the first marine vertebrate (like fish) genomes. The development of gene probes that can recognise the genes in target species that code for the creation of new natural products with potential therapeutic benefit for humans will probably be a result of this and related research. The immense and mostly unexplored biomolecular potential of the marine microbial population will increasingly be the focus of future studies. The next generation of medicines for enhancing human health as well as for enhancing the health of livestock and agricultural crops may be developed as a result of these research activities (Haselkorn R et al., 1973).

CONCLUSION

In conclusion, the marine environment has emerged as a significant source of therapeutic compounds with fresh modes of action. Only a limited number of candidates are included in clinical trials, despite the fact that hundreds of novel compounds are discovered each year. Sustainable availability of these chemicals from natural sources is the fundamental issue at hand. Different approaches have been explored to combat this issue, including the mariculture or aquaculture of source species, the creation of synthetic analogues of active chemicals, fermentation of the microbes responsible for the substance, etc. Using genetic engineering to transfer the genes encoding the synthetic enzymes that make the desired molecule to microorganisms that can be cultivated in large quantities is another potential option. A greater reliance on interdisciplinary sciences like pharmacology, chemical ecology, molecular biology, genomics, metagenomics, computational and combinatorial chemistry and biology will improve the development of these goods and services as well as the fundamental research from which they must be derived.

The study of marine natural products is now past the discovery stage and entering the second stage, where knowledge of relationships and processes is guiding research towards new sea-derived medicines. Future technology-related goods and services will be based on marine plants, animals, and microbes. There are countless chances for study in the field of marine drug development along the Indian coast due to its great biodiversity and plenty of marine resources in the form of estuaries, creeks, deep oceans, and the continental shelf.

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