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THE ANTIVIRAL PROPERTIES OF MARINE-DERIVED COMPOUNDS

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Abstract
HIV, HSV, and influenza are just a few of the viral infections that have plagued humans for ages and claimed millions of lives worldwide. However, because the majority of viral viruses continue to be resistant to numerous medical treatments, there are currently few effective medications available to treat infectious disorders. Many secondary metabolites from marine microbes that have antiviral qualities have been well documented up to this point. The viable antiviral compounds of marine microorganisms over the last decade are presented here. Additionally, the compounds' origins, bioactivities, and structures were explained. The most varied habitat for a wide variety of organisms is the ocean. Numerous amazing traits and bioactive compounds of medicinal importance are produced by creatures that thrive in the harsh circumstances of the sea. These metabolites have several immunomodulatory properties, including anti-inflammatory and antioxidant properties, and are active even at very low doses. Despite the development of COVID-19 vaccinations and ongoing medication research, there is currently no viable treatment for this deadly virus. To develop the tailored medication for COVID-19, researchers are delving deeply into the extensive database of bioactive compounds. It is challenging to apply the repurposed medications against the rapidly changing virus, which has shifting symptoms and a different route of transmission.
Keywords: Marine microbes, Marine natural products, Antivirus, Anti-influenza

1. INTRODUCTION

In the meantime, increased immigration, international travel, and urbanization have all contributed to the virus's rapid spread in the absence of a vaccine and antiviral treatment. However, the vast majority of antiviral treatments on the market today include drug side effects and cause viral drug resistance [1]. In addition to creating significant challenges for the therapeutic treatment of viral infections, the threat of medication resistance has a significant negative impact on the global economy. New drugs that can fight resistance in diverse ways are desperately needed, even though research on antiviral drugs has come a long way since the 1960 discovery of acyclovir, a

nucleoside analogue. Recent rapid advances in virology have led to the identification of numerous virus-specific processes or proteins as possible targets for chemotherapeutic treatment[2]. Antiviral drugs may target several viral life cycle stages, including reverse transcription, integration, translation, viral adsorption, viral fusion with cells, and others. Potential targets also include some of the viral enzymes that are involved in the production of viral DNA, RNA, and glycoproteins. For instance, acyclovir interferes with some key herpes virus enzymes that prefer nucleotide analogs.[9]. Despite the successful understanding of the viral life cycle over the past fifty years and the substantial research into effective vaccinations and drugs to prevent viral infections, a sizable fraction of the world's population remains afflicted with diseases like HIV in every generation. Furthermore, medication resistance to existing antiviral compounds by various viruses, including HIV type 1 or HSV-1, has always been a significant barrier to treating viral infections. This has spurred the quest for new, powerful compounds [3].
According to the Marin Lit database, more than 1200 novel natural products are described each year from a variety of marine sources, including algae, corals, sponges, and particularly bacteria. Additionally, a number of these natural antiviral drugs are currently on the market, and some have even progressed to the last stages of clinical research[4]. For instance, vidarabine is used to treat HSV infection. Its lead structure was initially extracted from the sea sponge. Marine microorganisms are one potential source of new secondary metabolites for antivirus software [13]. About a million microorganisms, including bacteria, fungi, actinomyces, and some cyanobacteria, can be found in one milliliter of seawater. These microorganisms have a lot of potential use in medical research. Furthermore, because of intense competition, some marine bacteria have metabolized particular chemicals to access incredibly restricted resources, even though they depend on symbiotic interactions with marine plants and animals to gain nutrients[10]. These secondary metabolites can be chemically classified as alkaloids, peptides, polyketides, terpenoids, etc., and have a range of biological actions, including antibacterial, antiviral, and anticancer effects. The most promising is the preclinical development of caroverine N, an anti-HIV drug produced from cyanobacteria. However, only a tiny number of naturally occurring compounds have been harvested, which contributes to the underdevelopment and ignorance of marine microbial resources.

2. REVIEW OF LITERATURE

Biopolymers with antiviral and anticancer effects, including polysaccharides, polyphenols, alkaloids, and terpenoids, are found in marine algae. These substances have the ability to trigger apoptosis in cancer cells, stimulate the immune system, and prevent viruses from multiplying. Marine algae's wide range of pharmacological characteristics make them an attractive choice for the production of long-lasting antiviral and anticancer medications. The fact that marine algae may be grown in saltwater and don't need freshwater or arable land is one of their key benefits; this makes them viable alternatives to traditional resources [5]. An underutilized source of distinctive chemical structures that could serve as the basis for innovative treatment regimens is the enormous biological heterogeneity seen in marine algae across a variety of maritime settings. Despite its medicinal potential, the introduction of chemicals from marine algae into clinical practice is fraught with difficulties, including those related to large-scale recovery, improving bioavailability, and obtaining regulatory clearances. To address issues like bioavailability and policy regulations, it is necessary to isolate particular chemicals in order to bring them within the scope of bulk production. Seaweeds are a novel technology for the creation of antiviral and anticancer medications, but only when paired with expertise, interdisciplinary collaboration, and environmentally responsible cultivation practices. Modern biotechnological methods, cutting-edge gene editing technology, and ecologically friendly aquaculture methods must all work together to fully utilize marine algae in the development of next-generation antiviral and anticancer drugs. Marine algae are an important area of scientific research due to their high concentration of bioactive compounds that may have antiviral and anticancer effects.
Significant pharmacological activity has been demonstrated by these substances, which include polysaccharides, phenolics, terpenoids, alkaloids, and sulphated carbohydrates. Because of the increasing resistance to synthetic drugs and the demand for new, natural remedies, marine algae are becoming a more significant issue and a potential source for drug development. The difficulties include completing clinical trials to support the therapeutic efficacy of these substances in human treatments, standardizing extraction procedures, and enhancing bioavailability. Further study is necessary to enhance the structural elaboration of antiviral polysaccharides and optimize their formulation for therapeutic usage. It has also been claimed that marine algae have anticancer properties, and there is evidence that they reduce tumor development, induce apoptosis, and suppress tumor spread. Several malignancies have demonstrated the cytotoxic properties of substances (terpenoids and bromophenols). Fucoidan, a sulphated polysaccharide obtained from brown algae, has garnered a lot of attention since it can cause apoptosis in cancer cells by activating caspase and preventing angiogenesis [11]. Additionally, algal alkaloids and flavonoids have shown particular inhibitory effects on key cellular functions such as cell cycle, invasion, and migration. Although promising results have been reported, these compounds' low bioavailability,

structural complexity, and lack of clinical studies restrict their direct use in cancer treatment[6]. Filling in these gaps, which have been made possible by biotechnological developments, nano-formulation methods, and mechanistic investigations of these gaps, would surely considerably boost future oncology treatments.

3. MATERIALS AND METHOD

Marine algae are autotrophic organisms that can be either micro or macro in size. Microalgae like diatoms, dinoflagellates, and cyanobacteria (blue-green algae) are unicellular, whereas macroalgae, or seaweeds, are multicellular and consist of green, brown, and red algae, respectively. Microalgae, such as cyanobacteria, diatoms, and dinoflagellates, are unicellular organisms. They have a variety of economic uses and are fundamental living creatures of underwater systems that are also crucial to biodiversity and underwater oxygenation. They inhabit marine environments and are divided into two major groups: microalgae and macroalgae. In addition to their significance for the ecosystem, marine algae have use in the food, medicinal, and biofuel sectors. Nevertheless, they also serve as significant stores of trapped blue carbon, which helps to mitigate global warming. For sustainable use and conservation, they should be categorized, bioactive components, and regionally and environmentally distributed [7].

Microalgae, which include dinoflagellates, diatoms, and cyanobacteria, are single-celled, nearly microscopic algae. In the marine food cycle, microalgae are the main producers of organic matter through photosynthesis. Spirulina and chlorella are two of the most significant microalgae species, valued for their nutritional and therapeutic properties. Nonetheless, it has been demonstrated that multicellular organisms like seaweed and macroalgae may grow on macroscopic scales. Seaweeds also create extensive underwater forest ecosystems that serve as homes and food sources for marine life. These are kelps (Macrocystis, Laminaria) and sargassum. Because macroalgae are rich in polysaccharides and bioactive compounds, they are employed inexpensively in food and medicine.

Many environmental conditions, such as temperature, salinity, and ocean current, affect the presence of marine algae. microalgae that grow well in cold-temperate coastal waters, such as those found in the Mediterranean and Northwest Pacific, when the right amount of oxygen and sea surface temperature are present. Monitoring and preventative efforts are necessary since these locations are more vulnerable to the rising trend of HABs. On the other hand, macroalgae like kelps and fucoid seaweeds are the main grazers of temperate coastal habitats, particularly in the Northeast Pacific and Southeast Australia. In locations with stable temperatures and sufficient light penetration, the macroalgal species will thrive. They contribute significantly to marine diversity and coastal definition in addition to lowering erosion and provide vital habitat for fish and invertebrates. The extent of macroalgae farming and its possibilities for commercialization are illustrated by recent research that show that marine algae may be grown on 20.8 million km2 of ocean space. The increased production of seaweed for farming can increase the role of marine algae in the global economy by storing carbon, producing eco-friendly biofuel, and ensuring food security.

4. RESULT AND DISCUSSION

Because they provide habitat and play a significant role in the creation of oxygen worldwide, marine algae are an essential part of marine ecosystems. Innovation in renewable energy, nutraceuticals, and pharmaceuticals has been fueled by the bioactive molecules found in marine algae. They are also important actors in mitigating climate change because of their role in sequestering blue carbon[8]. However, harmful algal blooms pose threats to the environment and the economy, highlighting the necessity of efficient environmental management [15]. Geographical characteristics also regulate the dispersion of algae and provide hotspots for biodiversity in different marine zones. For marine algae to be used sustainably, further study on its potential in the food, medicine, and energy sectors is necessary in addition to conservation efforts[14]. Optimizing their utilization while maintaining ecological balance will be made easier with knowledge of the functional diversity of marine algae, their effects on the environment, and their commercial applications.

Marine algae are promising sources of bioactive metabolites that could be used in medicine, especially as antimicrobials, antioxidants, and anti-inflammatory medicines. Extracts from microalgae have demonstrated a notable anti-proliferative effect on a number of cancer cell lineages, and microalgae have recently been revealed to possess anticancer properties. More specifically, some bioactive metabolites, such as red algae's halogenated mono- and sesquiterpenoids, exhibit antifeeding properties against marine creatures and are lethal to tumor cells. Red algae produce brominated metabolites with anticancer characteristics, such as terpenoids and phenols, by causing cell toxicity. Furthermore, rather than being tangible remedies, macromolecules—such as the polysaccharides found in green algae—remain the subject of research. More preclinical and clinical trials are required to determine their efficacy and safety, despite data suggesting that they can suppress angiogenesis, activate immunological responses, and induce apoptosis. Due to the lack of suitable tools and techniques, there is a growing trend toward the use of innovative extraction techniques rather than those antiquated ones.

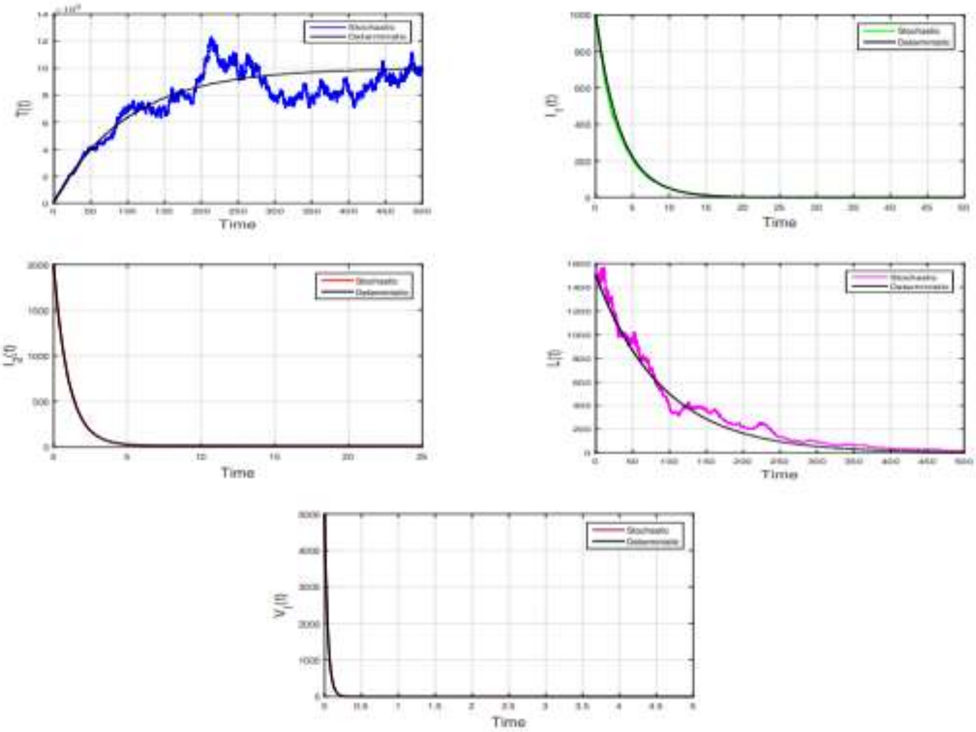

Figure 1: Trajectory of numerical simulations

Because they have more benefits than the conventional methods, new extraction techniques such as supercritical fluid extraction, subcritical water extraction, ultrasonic extraction, and microwave extraction are used to purify these chemicals.

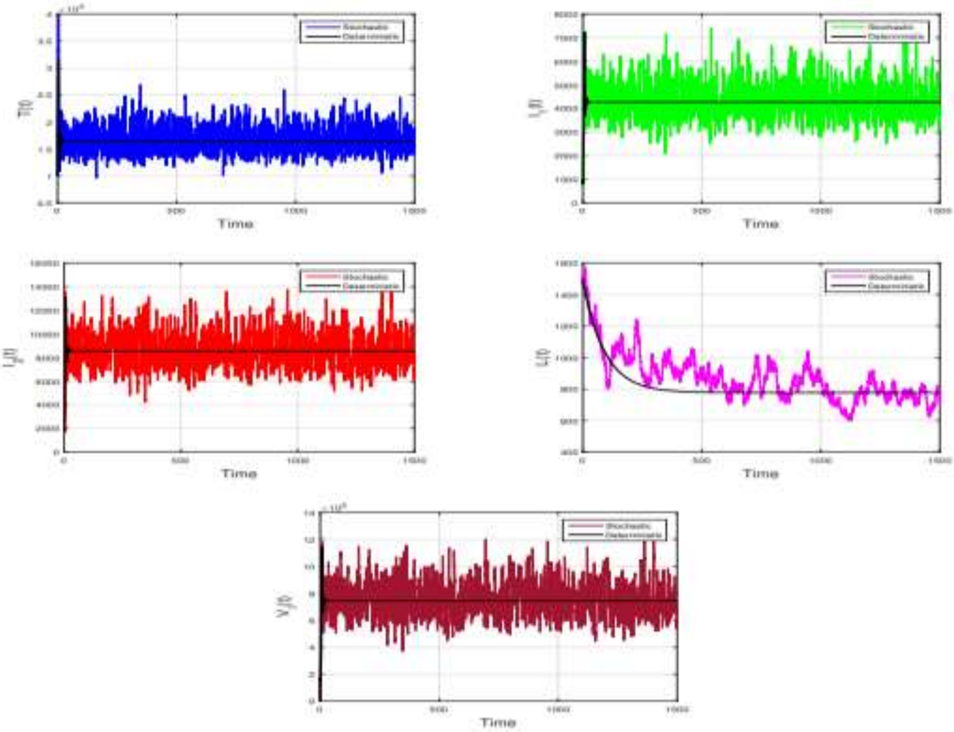

Figure 2: stochastic model

Marine algae's bioactive substances vary widely among species, growth environments, and environmental factors. These permissive settings are those that allow algae to grow in the best possible conditions. Different compounds are produced by each species; some are exclusive to particular types of algae, while others are present in all algae.

5. CONCLUSION

Over the years, there have been many epidemics that have killed millions of people. However, there are currently few treatments available for infectious disorders caused by deadly viruses. Furthermore, a significant number of antiviral medications have been found to exhibit viral resistance, which remains a challenge for antivirus treatment. Continuous development of new antiviral lead agents is essential as more and more novel virus kinds and drug-resistant strains are found. The logical pharmacological assessment of these compounds together will produce strong leads for the creation of adjuvants or antiviral drugs. However, only marine-derived Ara-A with anti-HSV activity has hit the market thus far, and only a small number of marine-derived drugs have advanced to clinical trials. Research on novel antiviral natural ocean products, especially marine microorganisms, is desperately needed in the fight against the global spread of COVID-19. The ocean's ecosystem is hailed as a source of a particular but yet unrevealed, unexplored resource in searching for new substances as therapeutic drug candidates. Natural products from the ocean can yield antivirals with special modes of action. It can be introduced further into clinical progress using chemosynthesis and biosynthesis approaches to bring such antiviral natural products. The discovery of new antiviral medications may be expanded by possible lead molecules through a multidisciplinary approach that included genomes, metabolomics, microbiology, natural products chemistry, and pharmacology. This will result in a worldwide search for clinically effective antiviral compounds.

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