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The Role of Natural Products in Drug Discovery and Development: Recent Trends and Prospects

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ABSTRACT

In the past, natural compounds and their structural equivalents have significantly influenced pharmacology, particularly for the treatment of cancer and infectious disorders. However, natural products also pose difficulties for drug development, such as technological obstacles to screening, isolation, characterization, and optimization, which led the pharmaceutical industry to stop looking for them after the 1990s. Recent advancements in technology and science, including enhanced analytical tools, genome mining and engineering techniques, and improvements in microbial culturing, are tackling these issues and creating new possibilities. In order to combat antimicrobial resistance, this has revived interest in natural compounds as drug leads. Although historically natural goods have been crucial in the drug development process, most Big Pharma companies have drastically reduced or stopped their natural product activities in recent years. This is even though in 2000, 2001, and 2002, the top 35 selling ethical pharmaceuticals worldwide included a sizable proportion of drugs produced from natural products. In addition to 15 natural product-derived compounds that were registered or in Phase III clinical trials at the end of 2003, there were 15 novel natural product-derived pharmaceuticals introduced between 2000 and 2003.Natural product research has recently gained more attention as a result of the inability of other drug discovery techniques to produce many lead compounds in important therapeutic areas like immunosuppression, anti-infectives, and metabolic illnesses. This review article provides a comprehensive overview of drug research and development, tracing its historical roots and exploring potential natural sources of medicines. It also clarifies the steps involved in the drug discovery process and highlights current trends and exciting future developments in this dynamic industry.

INTRODUCTION:

Human illnesses have traditionally been treated using natural resources including plants, animals, and minerals. But the foundation of contemporary medicine has always been ancient knowledge, and it will continue to be a crucial source of treatments in the future.

By over a thousand years, the history of medicine predates the development of human civilization. The majority of cutting-edge medications have previously been made with substances made from secondary metabolites obtained from natural sources (1).

Prior to the 20th century, the only treatments for human and domestic animal ailments were unrefined or semi-refined extracts of plants, animals, microorganisms, and minerals. In the 20th century, the receptor theory of drug action changed how people thought about drug use. Scientists concluded that individual chemical compounds in extracts, rather than some mystical "power of life," are the factors required for the biological activity of the drug because it was thought that the effects of drugs on humans are mediated by specific interactions of the drug molecules with biological macromolecules (proteins or nucleic acids in most cases).

As a result, extracts were replaced with pure, isolated chemicals in traditional therapies for illnesses, ushering in an entirely new era in pharmacology. The chemical structure of several bioactive substances implicated in the negative effects of medications made from unprocessed extracts was found.

Morphine, the primary ingredient in opium, and digoxin, a chemical produced from the flower *Digitalis lanata* that stimulates the heart, are examples of the pharmacological substances that were found in this fashion. Many of the newly discovered structures were chemically synthesized as synthetic chemistry advanced.

On the other hand, R & D department of the pharmaceutical industry has focus on the development of new medications, inventive/indigenous methods of administering existing medications, and the production of medications derived from plants while following the guidance of conventional medical systems (2).

The development of medicines has benefited greatly from the use of natural components. Many beneficial medications, including antibiotics and analgesics (painkillers), were initially created. Plants, fungi, and microorganisms are a few examples of natural sources.

These substances have unique chemical characteristics and structures that are particularly helpful in the search for new medicines.

Natural products can be modified and synthesized by scientists to create more potent, suitable, and secure pharmaceuticals, making them valuable resources in the search for novel therapeutic agents.

In medicine, natural products and age-old treatments have a lengthy history (3).

The pharmaceutical industry has relied heavily on chemicals derived from animals, plants, and microorganisms for lead compounds; out of the 877 small-molecule New Chemical Entities (NCEs) introduced between 1981 and 2002, 49% were natural products, semi-synthetic natural product analogs, or synthetic substances based on natural-product pharmacophores.

Despite historically playing a vital role in the creation of pharmaceuticals, the bulk of Big Pharma businesses have considerably reduced or stopped their activities using natural products in recent years. This is true even though a substantial number of pharmaceuticals derived from natural substances recently appeared on a list of the top-selling moral medications worldwide.

Despite this success, natural product pharmaceutical research has gradually decreased over the past 20 years.

There are a number of reasons why the pharmaceutical business is placing less focus on the discovery of natural compounds, including:

1.The development of high-throughput screening against specific molecular targets, which led many businesses to switch from extract libraries of natural products to libraries of synthesized chemicals that are "screen friendly."

2. The advent of combinatorial chemistry, which first held up the promise of more straightforward, drug-like screening libraries with a large variety of chemicals.

3. Shorter drug discovery timeframes were made possible by developments in molecular biology, cellular biology, and genomics, which boosted the number of biological targets.

It was difficult and frequently required multiple separation rings and structural elucidation to find natural product medications. Recent technological developments that solve these problems, combined with unmet expectations from lead-generation techniques now in use, have rekindled interest in natural compounds as potential therapeutic candidates (4, 5).

1.1 Drug discovery of natural products and history:

Nearly every civilization has amassed experience and knowledge of the utilization of natural goods due to the varied biological activities and therapeutic potentials of these substances. The earliest known medical text was composed in cuneiform on several clay tablets and dates back to ancient Mesopotamia around 2600 BC. It describes almost 1,000 different plants and plant products, including the juice of the poppy seed *Papaver somniferum*, the resin of the *Commiphora myrrha*, and the oils of the *Cedrus* species (cedar) (6).

Natural products (NPs) have historically been important in the development of new medications, particularly for the treatment of cancer and infectious diseases as well as for other therapeutic conditions including cardiovascular disease (using statins, for example) and multiple sclerosis (7).

The 341 plant-derived medications in the Charaka Samhita, the first treatise devoted to the theories and practices of Indian Ayurveda, were composed around 900 BC. The Sushruta Samhita (approximately 600 BC) focused primarily on surgical procedures but also provided descriptions of 395 therapeutic plants and 57 items derived from animals (8).

Traditional Chinese medicine (TCM) makes substantial use of organic ingredients. Prescriptions for Fifty-Two Diseases, the oldest Chinese medical text, was written around 350 BC and contains a list of 247 natural agents and about 150 combinatorial drug formulae, as well as practical guidance on the qualities, efficacies, and synergies of natural remedies (9,10).

A new era in the study and application of natural goods has begun thanks to modern chemistry. The ability to purify different substances and identify their structures has been

made possible by analytical and structural chemistry, which has also offered new information on how these molecules interact with the human body. After Friedrich Wilhelm Sertürner (1783–1841) of Germany successfully separated morphine from opium in 1805, Merck became the first company to commercialize the drug in 1826. In reality, instead of using crude extracts to produce medications, Western pharmaceutical corporations swiftly started to favor purified natural goods. In addition, chemists could now create numerous natural products using synthetic means rather than separating them from their natural sources, which was previously necessary and reduced the cost.

With many molecules remaining to be found, nature already offers opportunities for medication research. Nature has already produced a number of medications, including Taxol (*Taxus brevifolia*), quinine (Cinchona spp.), and artemisinin (*Artemisia annua*), which are all used to treat malaria to create novel medications in the face of the potential for future pandemics and diseases, drug discovery must make use of the natural resources already at hand (11).

A drug discovery program aims to find novel bioactive natural products that have strong biological activity of some kind. Nevertheless, it is inevitable to isolate well-known and unpleasant natural compounds that have no relevance to chemistry or pharmacology. Dereplication is the process of determining the known chemicals responsible for an extract's activity before bioassay-guided isolation.

The secret to successful natural product medication discovery and development will undoubtedly lie in an integrative strategy that combines the many discovery techniques with the recently established field of integrative biology. It is foreseeable that natural products will continue to play a crucial role in the hunt for novel, affordable, and safe medications. In this situation, the pharmaceutical industry needs to wake up, shift its perspective, and reallocate its resources to natural product-based drug discovery initiatives.

Natural products are good lead compounds that can be further modified during the drug development process, and they are also key sources for novel medications. The varied architectures and complex carbon skeletons of natural products have led to the significant use of natural products in medication discovery. Natural secondary metabolites are thought to exhibit greater "drug-likeness and biological friendliness than totally synthetic molecules"

since they have developed inside living systems, which makes them promising candidates for additional drug development.

Innovative techniques in drug discovery with natural products

Innovative and multidisciplinary strategies must be developed to employ natural products to entirely drive the creation of new pharmaceuticals used in clinics and other medical practices if new drug development is to be successful. These approaches may be combined to produce novel medicines that can solve the health problems of the present. The therapeutic efficacy of these substances has been proven to be diminished by the separation and evaluation of individual compounds from natural products as possible drug candidates, as the majority of chemicals discovered in, for instance, plants exhibit synergistic effects.

To combine and assess chemicals for their medicinal benefits, new techniques are thus required. Recent times have seen the use of system biology methodologies to direct drug discovery from natural products, understanding both the effectiveness and the absence of in various molecules (12).

- Combinatorial chemistry

While natural products have a considerably better hit-rate in high throughput screening with great chemical diversity, combinatorial chemistry produces larger libraries, but the compounds therein are relatively simple planar molecules. Improvements in the processes of isolation, purification, and characterization have also accelerated the production of natural product research, revitalizing the pharmaceutical industry's interest (13).

- High Throughput screening

A common technique for finding hits in scientific research, High-Throughput Screening (HTS) is particularly useful in drug development and has applications in biology and chemistry.

HTS enables a researcher to quickly perform millions of biochemical, genetic, or pharmacological tests using robotics, data processing and control software, liquid handling equipment, and sensitive detectors. By using this method, active substances, antibodies, or genes that alter a certain biomolecular pathway can be quickly identified. The outcomes of

these studies serve as a basis for developing new drugs and for comprehending the function or interplay of specific biochemical processes in biology (14).

- **Role of Genomics**

Identification of the plant species from which a molecule originated is one of the most crucial steps in the development of plant-based drugs. Future studies on a compound's therapeutic effects must attribute the compound's effects to the proper plant species and region. It is possible and must be avoided to use the incorrect plant source. Various chemicals from various plant species exist in variable concentrations. The development of precise plant and other natural product source identification criteria has been made possible by recent advancements in genomic technology (15).

For instance, DNA barcoding is a highly reliable method for identifying various plant species and other sources of natural products. Therefore, in contrast to morphological and other conventional approaches now in use, DNA barcoding and other modern techniques can give quick and precise identification of plants DNA barcoding is being utilized in biodiversity inventories to identify natural items and their origins due to its precision and speed (16).

- **Role of Proteomics**

In terms of finding and defining the mechanisms of action of numerous natural products, proteomic analysis has emerged as a complementary technique to genomic and transcriptomic approaches. Proteomics can also correlate with the quality of the natural product under consideration from protein expression, function, and biosynthetic cascades (17).

Similar to how genetic data can reveal protein patterns linked to natural products, advances in mass spectrometry, particularly the use of isotope tags and in combination with two-dimensional (2D) electrophoresis, can do the same.

- **Role of Metabolomics**

Metabolomics tools for molecule identification and evaluation are among the most cutting-edge methods for finding new medicines that can be used to tackle the growing global health threat. A method of identifying and quantifying the metabolites linked to a particular natural product is by delineating the Metabolomics profiling of those compounds.

For Metabolomics profiling of natural products, several well-established techniques have been applied, most notably mass spectrometry and more especially ultra-performance high-performance liquid chromatography-quadruple TOF MS (UPLC-MS). This has revealed novel substances with therapeutic properties.

For example, therapeutic compounds from plants including *Newbouldia laevis*, *Cassia abbreviata* and *Panax* herbs have been identified (18).

- **Role of big data**

The use of bioinformatics and computational methods for interpretation has become necessary due to the generation of large and complicated datasets through the use of "omics" analysis. The use and application of such complicated data will be made possible by statistical analysis, which will also help to define the pathophysiological effects of natural compounds. Additionally, details on the molecular impacts and target specificity of natural products can be discovered. Additionally, omics technologies can be used to assess data such as pharmacodynamics and toxicological testing of natural products and the molecules that are connected with them. The use of computational and bioinformatics tools has also made it simple to carry out procedures like docking and virtual screening (19).

- **Role of automation**

Automation has made it possible for humans to do incredible things that were before unthinkable. For instance, automation has made it possible to screen thousands of natural products and other molecules, greatly accelerating the process of drug discovery. High-throughput screening techniques and assays are used by almost all drug discovery businesses to expedite the investigation and assessment of compounds. With the help of computer software, several synthetic substances have been created and created. Adam and EVE are two examples of computational tools that can be used to find pharmacological targets and possible therapeutic candidates (20).

Absorption, distribution, metabolism, excretion, and toxicity (ADMET) qualities have an impact on compound design. The activity of the finished product is also crucial. Overall, the process of developing a medicine is multifaceted and complicated. Most significantly, having the necessary structural characteristics could not translate into having the proper biological

effect. Consequently, a balance between a natural product's or a compound's activity and characteristics is required (21).

- **Role of computer-aided drug design**

Synthetic compounds with structurally comparable natural products have been created in the hopes that they may make promising therapeutic candidates. However, in certain instances, these new synthetic molecules derived from natural materials might have designs unsuitable for medications or might prove unsuccessful as drugs during virtual screening and be eliminated. It is simple to determine whether a synthetic molecule is good or bad because there are certain criteria for selecting therapeutic leads. The "rule of three" and "rule of five" criteria, for instance, are frequently employed to select molecules that can be developed further during drug discovery (22).

To create new medications needed to address current and future global health concerns, cutting-edge technology, including artificial intelligence, must be combined with inventive drug design. Innovative computational and analytical techniques that can be used to separate compounds from extracts and the requirement to identify compounds with desired therapeutic effect are among the new technologies. Additionally, as many diseases are treated with drug combinations in any case, the pharmaceutical firms must give up on the "one wonder" drug approach and adopt a combination approach (23).

1.2 Natural source of drug

1.2.1 Plant Sources

It has been observed that nearly 75,000 species of plants exist on the earth, and only 10% have been used for traditional medicine, and in that 1 to 5% have been studied and have therapeutic value. Many drugs that are on the market today are discovered from natural sources.

The synthesis of the anti-inflammatory drug acetylsalicylic acid (aspirin) from the natural substance salicin extracted from the bark of the willow tree *Salix alba* L. is likely the most well-known and well-known example to date. As a result of research on the opium poppy *Papaver somniferum L.*, various alkaloids were discovered, including the commercially significant narcotic morphine, which was first described in 1803. (24)

The understanding of conventional medicine (complementary or alternative herbal remedies) has encouraged greater research into medicinal plants as possible medications and has resulted in the isolation of numerous natural compounds that have become well-known pharmaceuticals. (Table 1)

The Raw materials for Ayurvedic medicines were mostly obtained from plant sources in the form of crude drugs.

Example: Aspirin

Table 1. List of different medicinal active compounds from plant sources

Sr.No.	Name of drug	Category	Plant Name
1.	Paclitaxel	antimicrotubule agents, Antineoplastic agents, specifically a taxane.	derived from the bark of the Pacific yew tree (*Taxus brevifolia*)
2.	Taxol	Taxane chemotherapy, antineoplastic agents.	Pacific yew
3	Ingenol 3-o-angelate	hydrophobic diterpene ester, anticancer drug.	*Euphorbia peplus*, commonly known as milkweed
4.	Combretastatin A-4 phosphate	vascular disrupting agents, collapse of tumor	African willow tree, *Combretum caffrum.*
5.	Calanolide A	angular furanocoumarins,non-nucleoside reverse transcription inhibitors(NNRTIs)	Malaysian rainforest tree, *Calophyllum lanigerum*
6.	Artemisinin	antimalarial drug	extracts of sweet wormwood (*Artemisia annua*)
7.	Hydrobromide	antitussive	*Hyoscyamus niger* and *Atropa belladonna*,
8.	Apomorphine	dopamine agonists	aporphine alkaloids have been isolated from plants of 15 families
9.	Tubocurarine	non-depolarizing neuromuscular-blocking drugs	*Chondrodendron tomentosum*
9.	Aspirin	non-steroidal anti-inflammatory drug (NSAID).	bark from the willow tree
10.	Salicin	alcoholic β-glucoside, anti-inflammatory and analgesic	Most willow and populus barks yield salicin, but the principal sources are *Salix purpurea* and *S. fragilis.*
11.	Opium poppy	Papaveraceae phenanthrenes and alkaloids	The poppy plant, *Papaver somniferum.*
12.	Curcumin	polyphenolic compound and is classified as a natural phenolic compound.	plant-derived polyphenolic compound, naturally present in turmeric
13.	Piperlongumine	phytochemical of plant secondary metabolites amide alkaloid	constituent of the fruit of the long pepper (*Piper longum*), a pepper plant found in southern India and Southeast Asia

14.	N-trans-p-caffeoyl tyramine	hydroxycinnamic acids and derivatives.	*Lycium chinense* root bark
15.	Epigallocatechin-3-gallate	catechin class of phytochemicals	green tea [dried fresh leaves of the plant *Camellia sinensis* L. Ktze.
16.	Quercetin	flavonols, bioactive compound, anti-inflammatory	onions, grapes, berries, cherries, broccoli, and citrus fruits.
17.	Kaempferol	a flavonol under the category of flavonoids	aromatic ginger (*Kaempferia galanga*)
18.	Protocatechuic acid	dihydroxybenzoic acid, phenolic acid , antioxidant	*Olea europaea* (olives), *Hibiscus sabdariffa* (roselle), Eucommia ulmoides (du-zhong), *Citrus microcarpa* Bunge (calamondin), and *Vitis vinifera* (white wine grapes)
19.	Licochalcone A	chalconoid, a type of natural phenol.	derived from the roots of the Chinese licorice plant *Glycyrrhiza inflata.*
20.	Glycyrol	flavonoid, specifically a chalcone , carbohydrate	part of the glycerol observed in anaerobic plants comes from glycerol synthesis in the root and transport to the leaves and part is produced in the leaves.
21.	Glycyrrhetinic acid	glucosiduronic acid, a tricarboxylic acid, a pentacyclic triterpenoid, an anemone and a triterpenoid saponin.	the root and rhizome extracts of Liquorice
22.	Glycyrrhizin	triterpenoid saponin	licorice root (*Glycyrrhiza glabra*)
23.	Cannabidiol	recreational, medicinal and synthetic.	the flowering parts of the hemp plant, typically the buds and flowers
24.	y-Linolenic acid	polyunsaturated fatty acids (PUFAs).	evening primrose, black currant, borage, and fungal oils.
25.	Dehydrocostus	guaianolides and derivatives class of compounds.	derived sesquiterpene lactone
26.	Digitoxin	digitalis glycosides	Digitalis lanata
27.	Pilocarpine	cholinergic agonists	Pilocarpus Microphyllus (Jaborandi)
28	Betulinic acid	pentacyclic lupine-type triterpene	birch, eucalyptus
29	Bevirimat(PA-457)	androgens and derivatives	*Syzygium claviflorum, a Chinese herb.*

Fungi and bacteria as source for drugs

For thousands of years, macro and micro fungi have been a part of human existence. They were utilized as food (mushrooms), alcoholic beverage ingredients (yeasts), traditional medicine remedies, and cultural objects. They are now used in enzymes, biological controls, antibiotics, and other pharmacologically active products thanks to advancements in microbiology.(25)

Penicillin, which was discovered by Fleming in 1929 and was derived from the fungus Penicillium notatum, is unquestionably one of the most well-known natural product discoveries.(24) This finding resulted in the re-isolation, clinical investigation, and commercialization of synthetic penicillins by Chain, Florey, and others in the early 1940s, which ultimately changed the field of drug discovery research. (26)

Several drugs were invented and synthesized from fungi and bacteria species (Table 2).

Table 2. Different medicinal active compounds from fungi or bacterial sources

Sr.No.	Name of drug	Category	Name of species
1	Vancomycin	intravenous vancomycin injection is category C	*Amycolatopsis orientalis.*
2	Macrolide erythromycin	class of antibiotic	*Streptomyces erythraeus or Arthrobacter sp*
3	Ganoderic acid B	moderately active inhibitor against HIV-1 protease.	*Ganoderma species (Ganodermataceae family), such as Ganoderma lucidum.*
4	Amrubicin hydrochloride	anthracycline glycoside group of antibiotics.	de novo synthesis
5	Doxorubicin	anthracycline group of chemotherapeutic agents.	Streptomyces peucetius.
6	Torreyancin acid	diterpenoids	*Aspergillus niger* or *Candida* sp. from different sources of carbohydrates, such as molasses and starch-based media
7	Penicillin	beta-lactam antibiotic	Penicillium mold
8	Neomycin	aminoglycosides	*Streptomyces fradiae.*
9	Terramycin	tetracycline antibiotics.	*Streptomyces rimosus*

Marine algae source:

There are at least 30,000 species of algae (macroalgae, seaweed) in the world, and they provide the biosphere with oxygen, food for fish and humans, medicine, fertilizers, and a wealth of naturally occurring compounds with unusual structural properties (27).

Terpenoids are a group of chemicals that were mostly discovered in marine algae in the 1970s and 1980s. Many classes have been isolated as a result of chemical research into terpenoid-type structures, including brominated, nitrogen, and oxygen heterocycles, phenazine derivatives, sterols, amino acids, amines, and guanidine derivatives (28).

Different categories of medicine from marine algae sources are summarized in Table 3.

Marine sponges:

Sponges (Porifera) are sessile organisms without a nervous, digestive, or circulatory system that rely on a continuous water flow for nutrition, oxygen, and waste removal. All sponges eat 'current' or 'filter' food and have little physical defense against predators. They are thought to be the first multicellular organisms, and in roughly 500 million years, they have undergone relatively little modification. The studies of Bergmann on the separation and identification of C-nucleosides, spongouridine, and spongothymidine from the Caribbean sponge, Cryptotheca crypta in the early 1950s represent the first significant discovery of biologically active substances from marine sources (29).

Table 3. Medicinally active compounds from marine sources

Sr.No	Name of drug	Category	Marine Sources
1.	Plitidepsin	antiproliferative effects on cancer cells.	marine-derived anticancer compound separated from the Mediterranean tunicate *Aplidium albicans.*
2.	Ecteinascidin	alkaloids called tetrahydroisoquinolines	isolated from marine tunicates
3.	Trabectedin	anti-neoplastic or chemotherapy agents	*Ecteinascidia turbinata*
4	Cryptophycin	Dioxa diaza cyclo hexadecane tetrone cytotoxins	marine sponge *Dysidea arenaria*
5	Bryostatin	highly oxygenated macrolides	Bugula neritina
6	Halichondrin	polyether macrolides, anti-cancer	various marine sponges

Animal sources:

Additionally, animals can be a source of some drugs (Table 4).

Ten times more potent than morphine is the epibatidine that poison frogs from Ecuador have on their skin. Animal venoms and poisons have been used to treat a wide range of illnesses.

The COD fish is the source of COD oil. -Premarin is a medication made from the urine of female horses that is used to treat menopausal symptoms. -Pancrelipase is a medication derived from pigs and is used to treat pancreatic insufficiency (30).

Table 4. Medicinally active compounds from animal sources

Sr.No.	Name of drug	Category	Animal source
1.	Enoxaparin	low molecular weight heparin	made from heparin derived from pig intestines
2.	Pancrelipase	amylase, protease, and lipase(enzyme)	pig pancreas
3.	Dalteparin	anticoagulants ('blood thinners').	porcine intestinal mucosa origin
4.	Heparin sodium	anticoagulants ('blood thinners')	derived from pigs and cattle
5.	Poractant alfa	pulmonary surfactant	pig lung surfactant extracts
6.	Gelatin succinylated	protein derived from animal collagen	skin and bones of cows and pigs
7.	Polygeline	gelatin agents	It is derived from the collagen in animal connective tissue.
8.	Methylprednisolone sodium succinate	corticosteroids	derived from hydrocortisone and prednisolone.
9.	Eptacog alfa	recombinant coagulation factor VIIa (rFVIIa)	Baby hamster kidney cells (BHK Cells)
10.	Rituximab	monoclonal antibodies	Chinese Hamster Ovary (CHO) cells.
11.	Trastuzumab	monoclonal antibodies	recombinant DNA technology in a mammalian cell (Chinese Hamster Ovary) culture.,
12.	Idarucizumab	humanized monoclonal antibody fragment (Fab)	recombinant DNA technology in Chinese hamster ovary cells
13.	Rituximab	monoclonal antibodies	Chinese Hamster Ovary (CHO) cells.

Future perspective:

Two terms that define bioscience in the twenty-first century are biodiversity and genomics. In this discipline, biological variety is becoming more and more significant. Industries must adapt to the new rules and have a clear understanding of the biological resources they require as tools for innovation. On the other hand, if organizations with resources and titles truly wish to engage in and profit from the drug discovery process, they must devise strategies for promoting the sustainable use of their biological resources. Everyone should be aware that, despite a biological resource's enormous intrinsic value as a genetic information repository and an ecosystem's component, its monetary value may be negligible until a useful application is found and created.

Organizations should be ready to bear the financial risks as well as actively participate in the discovery process to realize that usefulness and reap the advantages.

CONCLUSION:

Without a doubt, one of the best "natural laboratories" for the production of different compounds, from simple skeletons to extremely complex chemical structures, is found in plants. Natural metabolites have better biological and pharmacological properties than randomly synthesized substances when compared as secondary metabolites. Biological activity-guided isolation techniques have been the mainstay of modern drug discovery from medicinal plants. These techniques have, for example, led to the isolation, identification, and discovery of significant medicines. The search for a chemical that triggers a particular biological reaction is the first step in the drug discovery process.

Natural products offer a distinctive component of molecular diversity and biological activity in the fiercely competitive world of modern pharmaceutical research, which is essential for medication development. Additionally, a remarkable structural diversity found in plant secondary metabolites complements chemically synthesized molecules or libraries in drug development initiatives.

An integrative approach by combining the various discovery tools and the new discipline of integrative biology will provide the key for success in natural product drug discovery and development.

However, untapped biological resources, “smart screening” methods, robotic separation with structural analysis, metabolic engineering, and synthetic biology offer exciting technologies for new natural product drug discovery. Advances in rapid genetic sequencing, coupled with manipulation of biosynthetic pathways, may provide a vast resource for the future discovery of pharmaceutical agents.

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