

Methods of Obtaining Bioactive Substances from Desert Plants

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Abstract: *Humans have relied on nature throughout their ages to cater for their basic needs including medicines to cure a wide spectrum of diseases. Plants have formed the basis for sophisticated systems of traditional medicines. For therapeutic agents many of the presently known lead compounds are natural products or their derivatives. Ethnomedicinal studies play a vital role to discover new drugs from indigenous medicinal plants. Green pharmaceuticals are getting popularity and extraordinary importance because vast opportunities for new drug discoveries are provided by the unmatched availability of chemical diversity and natural products either as pure compounds or as homogenous plant extracts. Therefore, in recent years the demand for herbal medicines and several natural products from a variety of plant species is consistently increasing.*

Keywords—medicinal plants; northern areas; Cholistan desert; secondary metabolites; biochemical profiling

Introduction

1. Role of plants in drug discovery

Medicinal plants have been used as a source of medicine in all cultures since times immemorial. Initially plants were used by the people to meet their nutritional requirements. The natural flora became a very useful source for health improvement and to cure many diseases across various human communities and a variety of plants species are offered which are still in use in many parts of the world such as Asia, South America and Africa for remedies against several diseases. Even though World Health Organization reported that the primary health care system for the 60% population of the world is represented by the traditional medicines yet a great number of plant species with potential biological activities were unexplored. The effectiveness of traditional medicines is now a putative fact because of their better compatibility with human body, better cultural acceptability in all over the world and lesser side effects. In various human cultures around the world more than 35,000 plant species are being used for their medicine purposes and for primary health care nearly 80% of the world populations rely on these traditional medicines which include the use of plant extracts most of the time.

Ethnomedicinal studies play a vital role to discover new drugs from indigenous medicinal plants and green pharmaceuticals are getting popularity and extraordinary importance because vast chances for new drug discoveries are provided by the unrivaled availability of chemical diversity and natural products either as pure compounds or as homogenous plant extracts. A decade ago the synthetic drugs because of unanticipated side effects were approved as safe and effective and had to be recalled and relabeled. The herbal medicines on the other hand, have no such adverse effects and because of combinations of medicinal constituents coupled with minerals and vitamins have benefits over synthetic ones. In current scenario, the attention of scientists has been diverted towards ethnomedicines due to the revival of knowledge in customary health practices throughout the world. Therefore, in recent years the demand for herbal medicines and several natural products from a variety of plant species is consistently increasing. A number of modern drugs have been discovered since the history of ethnobotany paying a distinct importance to the documentation of traditional information of medicinal plants. From medicinal plants 78% of new chemical constituents being natural or natural product-derived molecules are being used as a promising alternative treatment for infectious diseases. In modern pharmacopeia about 25% drugs and also a great number of synthetic analogs prepared on proto-type compounds which have been derived from plants are included.

Plants have an immense importance in the field of medicines because they have been utilized in medicines for the treatment of so many diseases for thousands of years. Beginning with morphine which was isolated from opium in the early 19th century, now active compounds are also isolated from medicinal plants. Earlier, when the role of medicinal plants in drugs was discovered then a number of drugs were isolated such as codeine, cocaine, quinine, digitoxin and morphine. Some of these drugs are still in our use. The extracts of several medicinal plants are very effective against microbial as well as parasitic infections. For example, several groups of antifungal proteins like glucanase, chitinase and proteins which are of low molecular weight and non-enzymatic in nature are present in the seeds of many medicinal plants and these proteins are being used for the protection of a developing embryo from many infections.

Importance has been given to ethnobotany field in Uzbekistan and a few studies have been done recently but the treasure of medicinal plants is being vanished with the passage of time and measures are still needed to save it. Uzbekistan is very rich in botanical wealth and has variety of medicinal and aromatic plants because of its exceptional phytogeography with varied climatic and edaphic factors such as soil conditions and multiple ecological regions. Out of 5700 about 400–600 species of medicinal plants are estimated to be found in Uzbekistan and only a small percentage of which have been biochemically investigated. In the early 1950s, for their basic healthcare needs about 84% population of Uzbekistan was relying on traditional medicines but now

due to modernization and urbanization the practice is limited only in the remote areas. Most medicinal plants from Uzbekistan are confined to the mountainous areas and then desert areas. A total of 1572 genera and 5521 species are identified in Uzbekistan having medicinal values for many diseases. To enlist the applications of these indigenous medicinal plants a very few attempts have been made and the information is incomplete as very few common plants are listed.

Materials and Methods

In an organism the presence of complete complement of small molecules is called metabolome. Various terms such as metabolomics, metabonomics, metabolic fingerprinting and metabolic profiling have been defined throughout the years. The variations in metabolite fluxes are revealed by metabolomics and therefore it is the decisive level of post-genomic analysis. Minor changes within gene expression is responsible to control these metabolite fluxes and transcriptomics and/or proteomic analysis are the methods to measure these changes while the analyses reveal post-translational control over the activity of enzyme involved. The high-throughput qualitative screening of a tissue or an organism with an analysis of sample comparison and discrimination as a main objective is called metabolite fingerprinting. The biochemical status of an organism is revealed by the measurements of intracellular metabolites which would be qualitative or quantitative. These measurements in turn can be used to assess and monitor the functions of different genes. Different approaches are used to detect and investigate metabolome. For metabolic fingerprinting, liquid chromatography–mass spectrometry (LC-MS) and proton nuclear magnetic resonance (¹H NMR) are frequently used techniques. In various fields of plant research, LC-MS as a technique for fingerprinting was applied such as plant biochemistry, food chemistry, chemotaxonomy and for establishing a control over quality of medicinal plants. Over the past 50 years, spectroscopic techniques coupled with some good extraction methods like chromatography have contributed natural product chemistry to a phenomenal success. Gas chromatography (GC) and liquid chromatography coupled to mass spectrometry (GC- and LC-MS) are the most suited equipment for fast and comprehensive analysis of ultracomplex metabolite samples. Using LC the separation of the thousands of molecules present in biofluids can reduce ion suppression by decreasing the number of competing analytes entering the mass spectrometer ion source at a time. This results in a selective approach that allows quantification and structural information, where sensitivities in the pg/mL range can be achieved readily. LC/MS technique has replaced some of the specialized methods which have been practicing in traditional clinical laboratories that used immunological, fluorometric, and biological techniques. High sensitivity and selectivity are the main advantages of LC/MS that allow quantitative analysis of secondary metabolites in complex biological matrices at very low concentrations.

Results

Botanical medicine or phytomedicine, also called herbal medicine is the use of plants' seeds, roots, berries, leaves, flowers or bark for healthcare and they have been used since the prehistoric times by the people worldwide to treat, control and manage a variety of diseases. Today, the infectious diseases have become worldwide a leading cause of death, therefore, their study has become a global concern. The emergence of multidrug-resistance in the pathogens is threatening the clinical efficiency of many existing antibiotics. It is a matter of fact that a number of infectious diseases have been treated with herbal medicines throughout the history of mankind. Due to incomparable availability of the chemical diversity, the plant extracts either as standardized natural products or as pure compounds have been providing unlimited prospects for new drugs. It is an urgent and continuous need that new antimicrobial compounds should be discovered having novel mechanisms of action and diverse chemical structures for re-emerging and new infectious diseases. Therefore, the attention of a number of researchers towards folk medicines is increasing continuously and they are trying to develop better drugs with antimicrobial activities. A continuous increase in the failure of antibiotic resistance and chemotherapeutics exhibited by the pathogenic microbial infectious agents has enhanced the importance of medicinal plants and they have been screening out for their potential antimicrobial activity.

Scientists began to isolate, purify and identify active constituents (principles) from medicinal plant extracts during the late nineteenth century and these efforts led them to find some of the vital drugs from medicinal plants which are still broadly used in the field of modern medicine. The extracts of several medicinal plants are very effective against microbial as well as parasitic infections. For example, several groups of antifungal proteins like glucanase, chitinase and proteins which are of low molecular weight and non-enzymatic in nature are present in the seeds of many medicinal plants and these proteins are being used for the protection of a developing embryo from many infections. Shoemaker et al has reported that there are over 400,000 species of plants on earth which have a huge reservoir of bioactive compounds, but only a small percentage of these have been examined in the research studies. When the bioactive compounds from traditional medicinal plants were investigated through screening programs, it resulted that these compounds possessed a considerable number of therapeutic properties. As a consequence a number of antitumoral drugs and antifungal agents are available for clinical uses and have been derived from plants. In another study, it has also been reported that plants are an important and continuous source of anticancer agents. During last 10-15 years, the fungal pathogens have gained resistance against presently engaged antifungal drugs and the adverse reactions or toxicity of the anti-infective. Due to this reason the importance of medicinal plants has been increased because they possess antimicrobial and antifungal activities.

Several epidemiological studies have shown that certain dietary elements play an important role in the prevention as well as in the etiology of different types of human cancers. The people who use plant-derived foods in great amounts such as vegetables,

fruits and soybeans have less chances of cancer. Although documentation was limited but it was observed experimentally that the preparations of certain plants may cure many diseases. Stem parts of *Euphorbia candelabrum* plant has been used against Newcastle Disease (ND) in poultry while the leaves of *Iboza multiflora* in combination with *Capsicum annum* fruits have been used to cure ND as well. Mtambo et al reported that in a local preparation in Northern Tanzania consisting of three plants, namely *Capsicum frutescens*, *Citrus limon* and *Opuntia vulgaris* possess a therapeutic efficiency against ND in commercial chickens. In parasites and pathogenic microbes, the development of multi-drug resistance and for systemic mycoses the non-availability of safe antifungal drugs has forced the researchers to look for new antimicrobial substances from some other sources, including plants. The medicinal plants which have been used traditionally produce a wide range of compounds with known therapeutic values. For the production of new antimicrobial drugs, those substances are considered the most which have little toxicity to host cells and can inhibit pathogens. The antimicrobial properties of medicinal plants from South Asia have been increasingly reported. In the local traditional systems of medicines, most of these medicinal plants have been used to cure different ailments including infectious diseases. For instance, *Terminalia arjuna* bark has been extensively used for a variety of purposes and particularly, the bark has been effectively used in cardiovascular therapy. Similarly, *Andrographis lineate* has been used for the treatment of snake bites.

Discussion

Various methods have been used to obtain compounds for drug discovery including isolation and purification of active compounds from medicinal plants and other natural sources, combinatorial chemistry, synthetic chemistry and bioinformatics approaches (e.g. molecular modeling). Although the pharmaceutical companies and funding organizations are getting interested towards combinatorial chemistry, molecular modeling and other synthetic chemistry techniques but natural products and particularly medicinal plants remain an important source of new drugs, new chemical entities (NCEs) and new drug leads.

Mostly the plant medicines have been used in their crude forms before nineteenth century and administered as infusions (herbal teas), decoctions (boiled extracts of bark and root), tinctures (alcoholic extracts) and syrups. Plants have also been applied externally as herbal washes and ointments (essential oils, poultices and balms). Researchers in developing countries who work on medicinal plants often experience a comprehensive exercise for the learning of names, uses and preparations of native plants, and in a number of marketplaces of villages of such countries the medicinal plants are being sold along with vegetables and other goods. The World Health Organization (WHO) has also recognized that in developing countries the agenda for effective health can never be accomplished by western medicine alone therefore it should be supplemented by other medicines which also include traditional herbal medicines of these countries. It has also urged and advised accordingly to utilize the resources of their medicinal plants and other systems of traditional medicines to accomplish primary healthcare goal. It is reported for developed countries that the patients of chronic diseases are turning towards herbal treatments as alternatives to modern synthetic drugs. In developed countries this interest in the use of herbal medicines is believed to be motivated by several factors which include:

- A. **The effectiveness of herbal medicines:** Medicinal plants are believed to be effective, gentle and most of the time specific in their function to organs or systems of human body, and the belief that herbal medicines can be used to treat certain diseases where conventional medicine fails.
- B. **Side effects of synthetic drugs:** Although synthetic or chemical drugs as compared to herbal medicines can have greater or quicker effects but they possess many adverse effects and risks. Herbal medicines are believed to be devoid of these adverse effects because millions of people around the world have been using herbal medicines against many diseases for thousands of years.
- C. **Synthetic drugs are highly costly:** Herbal medicines are generally less expensive as compared to synthetic ones.

Medicinal plants are continuously contributing to modern prescription drugs considerably by providing principal constituents which can be used to synthesize new drugs. From medicinal plants the search and use of drugs and dietary supplements have been hastened in the recent past. Biochemists, microbiologists, botanists, pharmacologists and chemists of natural products around the world are engaged to investigate medicinal plants for getting more and more phytochemicals and lead compounds which could be developed to treat different diseases.

Conclusions

Natural products are the chemical compounds found in nature that usually has a pharmacological or biological activity for use in pharmaceutical drug discovery and drug design. Drugs of natural origin have been classified as original natural products, products derived semi-synthetically from natural products, or synthetic products based on natural product models. Collectively, plants produce a remarkably diverse array of over 100,000 low-molecular-mass natural products, also known as secondary metabolites. Secondary metabolites are distinct from the components of intermediary (primary) metabolism in that they are generally nonessential for the basic metabolic processes of the plant. Many secondary metabolites have been isolated and characterized from a variety of natural sources, such as bacteria, fungi, and plants. They are of high interest and importance because they often exhibit a broad spectrum of biological activities. Phytochemicals are non-nutritive chemicals and responsible for medicinal properties of plants. Based on the functions they perform in plants' metabolisms, phytochemicals are divided into two groups i.e. primary and

secondary metabolites. Common carbohydrates, amino acids, proteins and chlorophylls belong to primary metabolites while alkaloids, terpenoids, flavonoids, glycosides, saponins, tannins, steroids etc are examples of plants secondary metabolites.

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