



The Role of Natural Products In Modern Pharmacology

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ABSTRACT:-

The article focuses on the current approach to understanding pharmaceutical products effect.it describes a paradigm shift in views on pharmaceutical action in correlation to the processes occurring under pathology .The paper discusses the role of regulatory processes in the development of a disease and a recovery .it points out the necessity of disease registration in order to early start a therapy .the author has also analyzed problems of modern pharmacology paying attention at the inability of monitoring the drug product effect during the treatment process and limited awareness of primary pharmaceutical interrelations with biological substrate .it covers the issues of Therapeutical efficiency depending on body oxygen saturation .special attention is paid to the water medium of a body directly related to the development of pharmaceutical effects .the article emphasizes the challenges of pharmaceutical effect depending on a dosage ,structural –functional heterogeneity of tissues , consecution of pathological development ,choice of its diagnostics etc.it outlines the most important ways of increasing the pharmaceutical efficiency based on the primary pharmacological effect.

KEYWORDS:- Pharmacodynamics, pathology, pharmaceutical effects, therapy,diagnostics, reducing -oxidizing potential ,regulation

INTRODUCTION :-

The word pharmacology is derived from Greek words Pharmacon means drug and logos means knowledge or study.Understanding how a drug or a substance is likely to modify the living system is crux of pharmacology it is based on should understanding of principles of physiology and pathology .by definition “pharmacology is the sciences that deals with the study of drug and their interaction with the living system .“

Many substances have been tried since time immemorial to minimize Suffering of mankind .every civilization had its own list of substance varying from plants and their extract to different kinds of soils and minerals which were used in different diseases.

It is expected from nursing staff to be familiar with the various system of medicines being practiced in contemporary word .the broad term complementary and alternative medicines (CAM) covers all the systems of medicines other than allopathic medicine

Pharmacology research is also a critical component in the development of modern in the effects of drugs and chemicals on living organisms where a drug can be broadly defined as any chemical substances ,natural or synthetic ,which affects a biological system. Pharmacology may involve how organisms handle drugs ,

identification and validation of new targets for drug action and the design and development of new drugs to prevent, treat and cure disease. personalized Pharmacology research is also a critical component in the development of modern medicine.

Natural products remain crucial in modern pharmacology, providing a diverse source of lead compounds for drug discovery, particularly for challenges like antimicrobial resistance. Recent technological advancements have revitalized interest in natural products research, overcoming previous hurdles in isolation and synthesis. Natural products offer unique structural diversity and biological optimization through evolution, making them valuable for developing new therapeutics despite the rise of synthesis chemistry.

HISTORY OF PHARMACOGNOSY

The term pharmacognosy has evolved significantly since it was first coined by Johann Adam Schmidt (1759-1809). It appeared in his manuscript entitled *Analecta pharmacognostical* in 1811 after his death (17). In those early days, the discipline focused primarily on the botanical description and phytochemical analysis of crude drugs prepared from medicinal plants. The botanical descriptions and microscopic applications of pharmacognosy were further developed in the 19th and 20th centuries (1) and formed the regulatory basis for the use of herbal preparations as medicine based on pharmacopoeial definitions. During these formative years, the discipline was considered a branch of medical sciences associated with the use of drug in their crude state.

Throughout the ages, humans relied on natural products. Natural products have earliest records from 2900-2600 BC documenting the uses of approximately 1000 plant-derived substances such as the oil of cedar species (cedar), commiphora myrrha (myrrh), Cupressus, morphine from opium poppy (*Papaver somniferum*) in 1803. Subsequent conversion into heroin was reported by Wright in 1874. In 1817, emetine was isolated from ipecacuanha, further other alkaloids such as strychnine (*Strychnos nux vomica*), quinine (*Colchicum* etc) were isolated.

Natural products are vital in modern pharmacology, serving as a source for new drugs due to their structure diversity, and their use is being revitalized by technological advances that overcome past challenges. While synthetic chemistry is important, natural sources remain a crucial pathway for developing novel therapeutics, particularly for diseases like cancer and infectious diseases and for tackling challenges like antimicrobial resistances.

CHALLENGES AND ADVANCEMENT

- 1) Past challenges: historically, challenges in isolating, identifying, and synthesizing these compounds led to a decline in interest in the 1990s.
- 2) Technological advancements: recent developments in analytical tools, genome mining, microbial culturing, and synthetic strategies are now addressing these challenges.
- 3) Revitalized interest: these new technologies are leading to a revitalization of natural products-based drug discovery, especially in the search for new antimicrobial agents to combat resistance.

THE CONTRIBUTION BIOLOGICALLY DERIVED PRODUCTS TO THE DEVELOPMENT OF NEW MEDICINES

The annual global medicine market is worth about 1.1 trillion US dollars. About 35 percent of these medicines originated directly or indirectly from natural products including plants (25%), microorganisms (13%) and animals (about 3%): natural-derived products constitute an extremely important resource for global pharmaceutical companies working on the development of new medicines. They are used as: i) a direct source of therapeutic agents (both as pure drugs and phytomedicines); ii) a source of raw material for development of complex, semi-synthetic drugs; iii) prototypes for design of lead molecules; iv) as taxonomic markers for discovery of new drugs. About one-third of the best-selling drugs in the world are natural products or their derivatives. Of the 520 new drugs approved by the Food and Drug Administration (FDA)

between 1983 and 1994, 39% were natural products or antibiotics and anti-cancer drugs are derived from natural products or derived from natural products and about 60-80% of antibiotics and anti-cancer drugs are derived from natural products (Cragg et al. 1997, Strohl 2000, Harvey 2000). Recently Newman and Cragg (2016) assessed the role of natural products in the drugs approved by the FDA between 1981 and 2014. They found that in this period the FDA approved by the FDA between 1981 and 2014. They found that in this period the FDA approved 1,562 drugs, 64 (4%) were unaltered natural products, 141 (9.1%) were botanical drugs (mixture), 320 (21%) were natural products derivatives and 61 (4%) were synthetic drugs but with natural products pharmacophore.

There are many examples of globally best-selling medicines that originated from natural products -notably from higher plants, microorganisms and animals. Some good examples are i) the anti-cholesterolaemic agents Simvastatin, lovastatin, pravastatin and atorvastatin; ii) the anti-hypertensive agents: captopril and ramipril; iii) the antitumoral agents taxol, docetaxel and camptothecin; iv) the antibiotic and antifungal agents: penicillin, erythromycin, clarithromycin and amphotericin B. (Strohl 2000, Harvey 2000, Li and Vederas 2009). As noted above animals are the source of about 3% of the new drugs approved by the FDA, but many important and best-selling drugs originated from animals, mainly from toxins. Captopril, an angiotensin-converting enzyme (ACE) inhibitor and anti-hypertensive drug was discovered by Brazilian pharmacologist Sergio H. Ferreira (1934-2016) in the venom of the Brazilian viper, *Bothrops jararaca*. This is discussed in more detail in the next section. Enalapril was later developed using the same mechanism. Other examples of animal-derived drugs are exenatide, a glucagon-like peptide 1 agonist used to treat type 2 diabetes mellitus, which was originally isolated from the Gila monster lizard (*Heloderma suspectum*) and ziconotide, a peptide isolated from *Conus magus* which is a calcium 2.2 channel blocker used to treat neuropathic pain (for more detail about new drugs derived from animal toxins).

There are some clear advantages to the use of natural products in the process of drug discovery and development. They represent chemical novelties and compared with other sources they can originate lead drug candidate for complex targets. Further, naturally derived constituents possess a chemical diversity unmatched by any synthetic chemical collection; they can possess bi- and tri-dimensional complex structures yet be capable of being absorbed and metabolised in the body (Strohl 2000). On the other hand, the use of naturally derived molecules as source of new medicines also presents some challenges because of the lack of specific legislation governing access to biological resources in biodiversity-rich countries.

It may also be physically difficult to gain access to natural habitats and the processes necessary to isolate, purify and chemically characterize active compounds are costly and time-consuming. Most pharmaceutical companies complain about the difficulty of assaying some natural molecules in modern drug discovery programmes (high throughput screening) compared with synthetic compounds. Finally, it is important to emphasise the great structural complexity of natural molecules, which makes it difficult to synthesise analogous lead compounds (Strohl 2000, Harvey 2000, Li and Vederas 2009). Without doubt the global pharmaceutical industry has benefited greatly from biodiversity-rich countries the last two centuries when it comes to identification of novel therapeutic targets involved in many significant chronic diseases and, particularly, the development of new drugs for the management of certain chronic diseases (see for review Newman and Cragg, 2016). Brazil is the most biodiverse country in the world, with more than 50,000 species of higher plants (20 - 22% of the planetary total), more than 500 species of mammals, about 3,000 species of fish, more than 1,500 species of birds, more than 500 species of amphibians and millions of species 500 species of amphibians and millions of species of insects and microorganisms. However, to date few innovative products have been developed and marketed in Brazil or abroad from active constituents derived from Brazilian biodiversity.

Despite the growing number of scientific articles on plants over the last 4 decades (for review see Calixto 2005, Dutra et al. 2016), we have seen that there is a negative correlation between the number of scientific papers published on Brazilian biodiversity and the number of innovative products derived from the Brazilian biome that are available on the market. I return to this topic later on in this article.

Drugs Developed from Traditional Medicines that Follow the Traditional Uses

TM is too valuable to be ignored in the research and development of modern drugs. Though it has an enigmatic character, there are also wide contexts for its use in terms of non-Western medical technology or activities. In TM, a single herb or formula may contain many phytochemical constituents, such as alkaloids, terpenoids, flavonoids, etc. Generally speaking, these chemicals function alone or in conjunction with one another to produce the desired pharmacological effect [35]. It is notable that a lot of plant-originated drugs in clinical medicine today were derived from TM [21]. In addition, it has been demonstrated that the many valuable drugs derived from plants were discovered through their application in TM [2].

Almost 20 years ago, a thorough investigation of the pharmacopoeias of developed and developing nations and the associated world scientific literature was conducted as part of the WHO's TM Program. The aim of that study was to determine whether TM really had inspired modern drug discoveries and whether there was any correlation between the current use of various compounds and their application in TM. The study focused on various compounds used in drugs derived from plants in different countries, and it established that TM had indeed played a significant role in developing effective new drugs. That study focused on 122 compounds, 80% of which were found to be related to pharmaceutical effects in folk medicine, and it was determined that these compounds originated from 94 plant species [2].

The acceptability, convenience, and accessibility of TMs have been, and will be, helpful for new drug research [13]. As noted above, artemisinin and other antimalarial drugs are examples of modern drugs based on TMs. Early in China's Jin Dynasty, Doctor Hong Ge (AD 284–384) recorded the efficacy and related details of *Artemisia annua* L. in treating malaria in his book *Zhou Hou Bei Ji Fang*. That is the earliest record anywhere of treating malaria with *Artemisia annua* L., and it shows that Chinese physicians 1700 years ago had reached a sophisticated level of medical treatment [53,54].

Artemisinin is known as qinghaosu in Chinese, and its study has made significant progress, including the synthesis of new artemisinin analogs and derivatives, and research efforts into the biological activities and related mechanisms. As a result, artemisinin, as well as its effective derivatives, are extensively applied throughout the world as new-type anti-malarial drugs [55].

The discovery of artemisinin can be traced back to the 1960s, when tropical malaria was a serious problem during the Vietnam War. North Vietnam requested China to help tackle the malaria problem. The Chinese government approved a project for malaria control and drug research in 1967. The research group made its investigations and carried out a large-scale search of the literature on the subject. As part of the phytochemical and pharmacological research effort, a lot of Chinese herbal medicines were screened and investigated with respect to their toxicity or efficacy. Eventually artemisinin was derived from *Artemisia annua* L. in 1972 [53,55,56]. Artemisinin is quite different from previously-used antimalarial drugs, such as chloroquine, in that it has a novel structure, with a sesquiterpene lactone bearing a peroxy group, and it does not contain nitrogen heterocycles. Compared with previous antimalarial drugs, artemisinin has the merit of high efficiency, quick effect, and low toxicity. Artemisinin is effective in treating various forms of malaria, such as falciparum and cerebral malaria, which are resistant to chloroquine, and its mechanism of action is different from traditional antimalarial drugs. The discovery of artemisinin was a great success for TCM at a special period in China's history, and it was achieved through a well-organized team of hundreds of researchers [56]. Since that breakthrough, scientists have conducted comprehensive research in such areas as pharmaceutical chemistry, organic synthetic chemistry, and chemical biology. Through etherification and esterification, they have produced a series of well-known new drugs, such as artemether and artesunate. Those drugs have improved efficacy and solubility, which are of benefit for patients receiving oral or intravenous administration and have overcome the high parasite recrudescence rate and low solubility of artemisinin [55,56,57]. Most importantly, one of these scientists, Youyou Tu, was just awarded the 2015 Nobel Medicine Prize for her significant devotion in discovering artemisinin.

The discovery of artemisinin illustrates how TCM constitutes a great store of knowledge about natural products, such as Chinese herbs, and holds much future promise. The discovery of successful new drugs can proceed by profiting from knowledge [56]. Some drugs or compounds isolated from Chinese herbal medicine

Sources of natural products as a pharmaceutical.

Many people have relied on the findings of hundreds of years of experimentation utilizing plant products as conventional medicines and treatments without even any awareness of the bioactive components in the plants themselves (Kinghorn et al., 2011; Hicks, 2014). Indian tribes in Southern California used the herb *Salvia* in childbirth to treat newborn babies with hot ashes of *Salvia* genus species to stimulate their growth and protect them from any form of respiratory complications for the rest of their lives (Hicks 2014). Ayurvedic practitioners have recorded and stated that the plant *Alhagi maurorum* Medik. (Fabaceae) produces a delicious gummy compound primarily composed of sugar called melezitose and has significant efficacy in treating constipation, anorexia, dermatosis, fever, epistaxis, obesity, and leprosy (Duke et al., 2007). Furthermore, *A. maurorum* Medik. (Fabaceae) was used by various communities; for example, a boiled extract of the roots was used to treat bloody diarrhea, while Konkani people smoked it to treat asthma (Duke et al., 2007). *Ligusticum scoticum* L. (Apiaceae), a common herb of Eastern America and Northern Europe, is used to treat flatulence and is also considered an aphrodisiac and sedative (Beith 1995).

In addition to plants, various resources have produced significant amounts of NPs that have been exploited as a medication in the traditional systems. For instance, *Piptoporus betulinus*, a fungal species, was used to generate charcoal that showed antibacterial and disinfecting properties (Swanton 1915) and was used in dressing to heal wounds. Field mushroom *Agaricus campestris* L. ex Fries (Agaricaceae) grew in Northern and Southern temperate zones and the Caribbean. This mushroom is being used to help people with throat cancer feel better after surgery (Hatfield 2002). At the same time, limited research evidence reported the medical application of lichens since lichens are widely employed in folkloristic applications (Muller 2001). *Usnea dillenii* ex Adanson, which is intended to manage scalp problems and also to be a constituent of shampoos (anti-dandruff); in addition, *Parmelia omphalodes* L. Acharius (Parmeliaceae) which is common in the British Empire and is dusted on socks before commencing a long journey to alleviate foot inflammation, as well as in Ireland, it is being used to treat bad sore Purvis (Allen and Hatfield 2004).

The marine ecosystems also contribute to producing various therapeutic medicines, but their exploration is impoverished. An algal beverage made from *Chondrus crispus* Stackhouse (Gigartinales) and *Mastocarpus stellatus* Stackhouse (Phylloporaceae) was employed to treat colds and chest infections such as tuberculosis, renal problems, and burns (Vickery 1995). In the Aran Islands, the red algae *Porphyra umbilicalis* (Linnaeus) Kützting was used to treat indigestion and breast cancer (Borlase 1758). Folkloristic information about the medicinal properties of natural compounds has served as a framework for the research going into the pharmaceutical companies for drug manufacturing. Following advances in dereplication strategies at the beginning of the 19th century, plant preparations with therapeutic benefits were thoroughly researched. By the mid-twentieth century, crude medicinal preparations were substituted with partially purified natural medicines (Mishra and Tiwari 2011). Following that, a timeline of natural compounds is exploited as a pharmaceutical to better comprehend significant drug development in modern medicine.

Conclusion and future prospective

Natural products will continue to be a reliable source for pharmaceutical drug invention. Finding the correct technique for drug development from biological substances is very crucial. Most findings are part of the constant effort from herbal remedies to commercial medications. This is a well-known fact that researchers explored chemicals that could perform a therapeutic approach from herbal medicines. Although indigenous knowledge concerning plants and pharmacological assisted drug development from natural products is more convenient, these approaches are time-consuming and have poor productivity. Plant-based novel therapeutics assist researchers in developing new medications by revealing harmful effects.

Innovative approaches are required for the development of medication from natural products. To accomplish these, novel methodologies focused on the natural product have aided in the discovery and development process, converting natural compounds into active pharmaceuticals. In this context, technical advancements have enabled the study of complicated chemical characteristics, leading to the development and synthesis of many molecules. Several breakthrough medications have been recently produced from natural substances or components derived from natural resources. These retained natural products at the center of medication development and recent

technology advancements will help to boost the performance rate of novel therapeutic molecules. Consequently, natural substances will continue to perform an essential role in medication development and in our efforts to address public health issues and achieve health-related sustainable and economic development.

However, substantial clinical competence and cognitive reasoning are required. Biological compounds generated from microorganisms' resources can have limitations, such as higher toxicological properties. The drug development from microbes is complex and requires superb dereplication strategies. Almost all valuable natural compounds result from the cellular biosynthesis of secondary metabolites. The primary approach for natural drug development consists of pathogenic factors, target receptors, and disease-induced animal models that are more convenient than the other drug development strategies. Infectious agents and hideous diseases limit the drug development process based on natural compounds. The perfect animal model needs to be established with arduous effort for such a challenging context. Intrinsic biomolecules also serve as a model for developing novel medications, enabling researchers to optimize natural molecules' activity and toxicity. Drug development from the natural product can make tremendous advances due to the continued exploration of disease-related mechanisms. With the advent of modernistic techniques, there is new hope for higher success rates of the new drug. As research progresses, more advanced molecular technologies are revealed, supporting the investigation of active chemical mechanisms. We can use network pharmacology and computational biology to quickly identify the active ingredients in natural remedies.

Further, the hypotheses are then confirmed using pharmacological testing. The next biotechnological advancement will expand natural products' biochemistry with molecular understanding. The remarkable improvement in biological sciences and technology has expedited drug development using cellular and molecular experiments from natural ingredients. Even though natural products play an essential function in developing new medications, natural product-based drug development faces several challenges. Natural product medication development is becoming increasingly complex. The key to success in natural product drug discovery and development will be an integrative approach that combines various discovery tools and the new discipline of integrative biology. More focus should be directed to innovative drug discovery methodologies and technology. The critical components for eventual accomplishment in this practice are thorough monitoring, critical analysis, and innovation.

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REFERENCES

- 1) Atanasov, A. G. et al. Discovery and resupply of pharmacologically active plant-derived natural products: a review. *Biotechnol. Adv.* 33, 1582–1614 (2015).
- 2) Harvey, A. L., Edrada-Ebel, R. & Quinn, R. J. The re-emergence of natural products for drug discovery in the genomics era. *Nat. Rev. Drug Discov.* 14, 111–129 (2015)
- 3) Newman, D. J., & Cragg, G. M. (2020). Natural products as sources of new drugs over the nearly four decades from 1981 to 2019. *Journal of Natural Products*, 83(3), 770–803.
- 4) Khalid S, et al. Medicinal Importance of *Holoptelea Integrifolia* (Roxb). *Planch* – Its Biological and Pharmacological Activities. *Nat Prod Chem Res.* 2013; 2:124.
- 5) Khatun A, et al. Scientific Validation of Eight Medicinal Plants Used in Traditional Medicinal Systems of Malaysia: A Review. *American-Eurasian Journal of Sustainable Agriculture.* 2011; 5: 67-75
- 6) Li, J. W., & Vederas, J. C. (2009). Drug discovery and natural products: End of an era or an endless frontier? *Science*, 325(5937), 161–165
- 7) Newman, D. J. & Cragg, G. M. Natural products as sources of new drugs from 1981 to 2014. *J. Nat. Prod.* 79, 629–661 (2016).