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Mini Review: Open Access

An Appraisal of Plants as a Natural Source of Conventional Drugs

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ABSTRACT

Despite the recent interest in molecular modeling, combinatorial chemistry and other synthetic chemistry techniques by pharmaceutical companies, medicinal plants remain an important source of new drugs, new drug leads and new chemical entities. Whereas purified compounds from higher plant species have been used directly as drugs, several compounds extracted from plant species have been subsequently used in chemically modified forms as drugs while others have served as templates for synthetic analogues. This review was undertaken to highlight examples of conventional drugs derived from plant sources, their clinical indications and profile the challenges in the process of drug discovery from plants. Although drug discovery from medicinal plants continues to provide an important source of new drug leads, numerous challenges are encountered including the procurement of plant materials, the selection and implementation of appropriate high-throughput screening bioassays and the scale-up of active compounds.

Keywords: Plants, Conventional drugs, Template molecule

INTRODUCTION

Historical development of drugs has its foundation firmly set in the study of natural remedies used to treat diseases over centuries [1]. Plants are a reserviour of potentially useful chemical compounds not only as drugs, but also as unique templates that could serve as starting point for synthetic analogues and as interesting tools that can be applied to a better understanding of biological processes [2].

Between 1983 and 1994, 41% of new approved drugs had natural products as their source. Infact 60% of the newly approved anticancer drugs were from natural products [3]. It has been estimated that in developed countries such as United States, plant derived drugs constitute as much as 25% of the total drugs in clinical use, while in developing countries, the contribution is as much as 80% [4]. These countries provide two third of the plants used in modern system of medicine and the health care system of rural populations in developing countries depend on indigenous systems of medicine [5].

Fabricant and Farnsworth [2] identified 122 compounds of defined structure, obtained from only 94 species of plants, that are used globally as drugs and demonstrated that 80% of these have had an ethnomedicinal use identical or related to the current use of the active elements of the plant [2].

One of the successful strategies for investigation of medicinal agents from higher plants includes the pharmacological screening of plant extracts followed by a bioassay-guided fractionation of active principles from the plant materials leading to the isolation of pure constituents of medicinal value [6].

Rishton has observed that the limitations of artificial biochemical assays as applied to the screening of natural extracts must be realized in order to capitalize on the vast natural molecular diversity and rich ethnobotanic data that has emerged worldwide [7]. This mini review aimed at documenting conventional drugs that are derived from plants. Several purified compounds from plant species used directly as drugs have been documented, several compounds extracted from plant species are subsequently used in chemically modified forms as drugs while others serve as templates for synthetic analogues. These have been highlighted in the proceeding sections.

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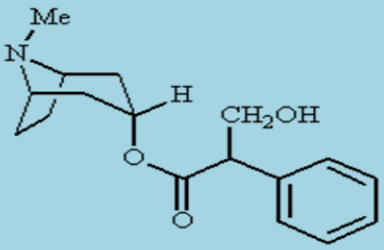
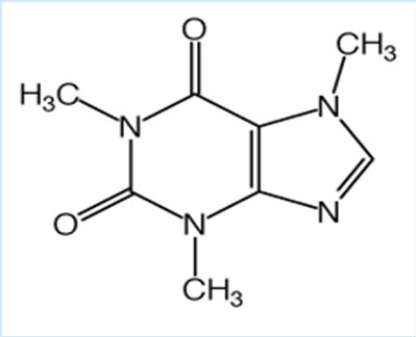
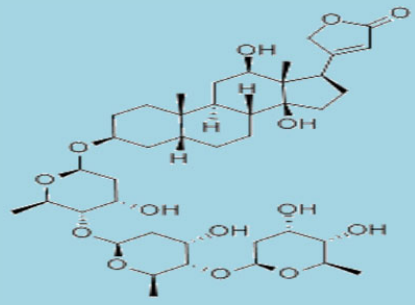
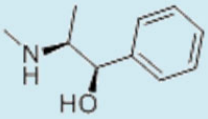
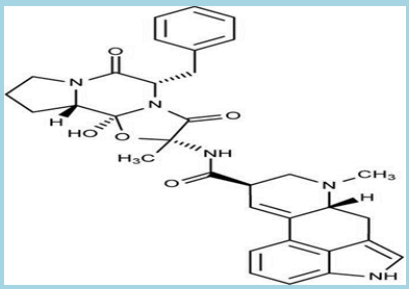
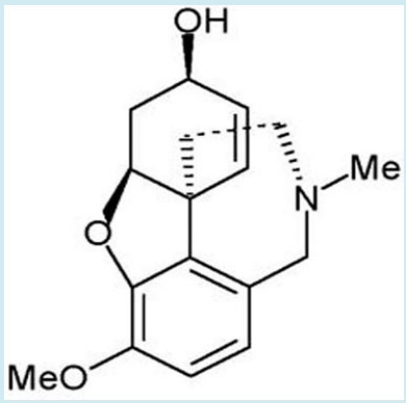
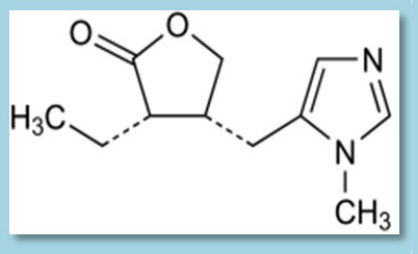
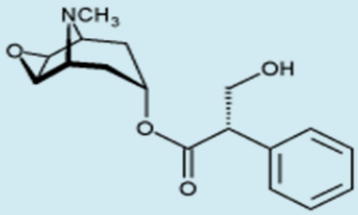
PURIFIED COMPOUNDS OF PLANT ORIGIN USED AS DRUGS

Purification of compounds of plant origin involves the extraction and isolation of the active constituents from the plant extract [8]. **Table 1** shows examples of purified compounds from plant species used directly as medicine(s).

Table 1. Examples of purified compounds from plant species used directly as medicine(s).

Purified Compound and plant source	**Chemical structure**	**Clinical use**
Atropine from deadly night shade, *Atropa belladonna* And other genera from family: Solanaceae		Cholinergic receptor blocker used in symptomatic relief of GIT disorders characterized by smooth muscle spasms; Reversal of excessive bradycardia; Antidote to organophosphate poisoning; dilating pupils and drying secretions.
Caffeine from coffee, *Coffea arabica* and Tea, *Thea sinensis* *(Rubiaceae)*		Central nervous system stimulant, diuretic
Digoxin from the Fox glove, *Digitalis purpurea, D. lanata (Fam.* Plantaginaceae)		Increases force of myocardial contraction and reduces conductivity within the AVN hence used in the treatment of Heart Failure and Supraventricular arrhythmias particularly arterial fibrillation and arterial flutter.
Ephedrine from Ephedra sinica and other species		Nasal decongestant, reversal of hypotension from spinal or epidural anaesthesia, bronchial muscle relaxant

Ergotamine from Ergot of Rye which is dried sclerotium of *Claviceps purpurea* Tulasne (Claviciptaceae)		Prevention and treatment of migraine headaches
Galantamine from snow drop, *Galanthus woronowi*, G.nivalis and other species of the family: Amaryllidaceae.		Galantamine is a reversible inhibitor of acetylcholinesterase and is used to treat mild to moderate dementia in Alzheimer's disease.
Pilocarpine From Jaborandi leaves (*Pilocarpus jaborandi*)		Miotic used in the management of raised intra ocular pressure. It is used temporaliy before an operation for angle-closure glaucoma.
Scopolamine (Hyoscine) from Mandrake (Mandragora officinalis)		CNS and GIT stimulant.

Additionally, plants have played a significant role in the treatment of cancer and infectious diseases. The discovery and introduction to market of paclitaxel, the vinca alkaloids (Vincristine, Vinblastine), etoposide and support drug discovery from plants [9].

Chemical modifications of natural compounds from plants

Compound(s) extracted from a plant species can subsequently be used in chemically modified form as medicine. Chemical modification of a natural compound can be done to achieve any of the following purposes [8]:

i. To increase solubility of the extracted compound
ii. To improve potency of the compounds
iii. To overcome multidrug resistance as in Paclitaxel-MDR cancers
iv. To reduce toxicity of the compound before use.
v. Modification can permit certain natural compounds that are difficult to isolate and purify, and compounds that are difficult to synthesize to be assayed.
vi. Modification increases the probability of discovering new leads and drug candidates from natural products.

Aminophylline is a stable mixture or combination of Theophylline (1,3-Dimethylaxanthine) and ethylenediamine. The ethylenediamine confers greater solubility in water. Aminophylline is 20 times more soluble than theophylline alone and is used for the treatment of asthma and stable chronic obstructive pulmonary disease [10] **(Figure 1)**.

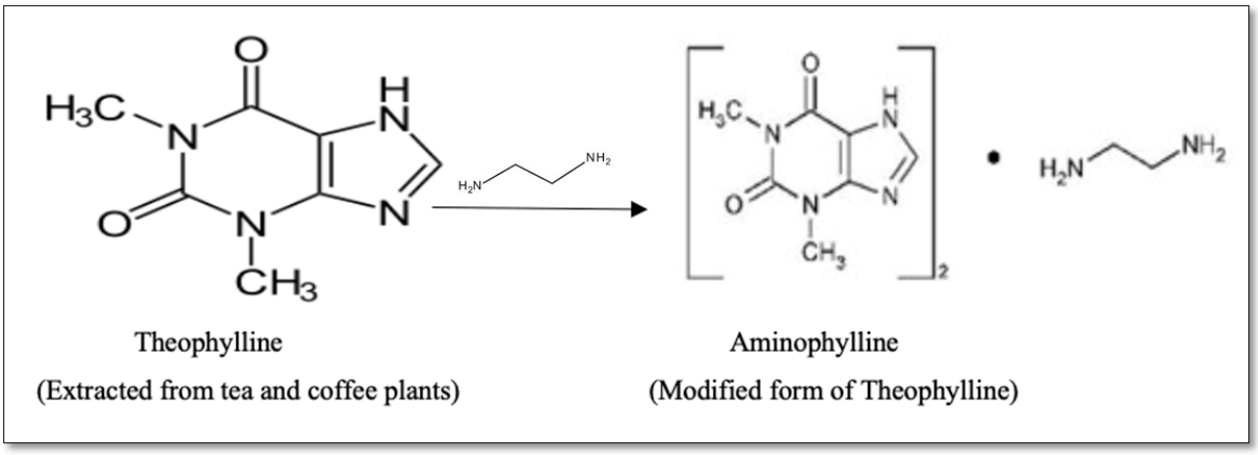


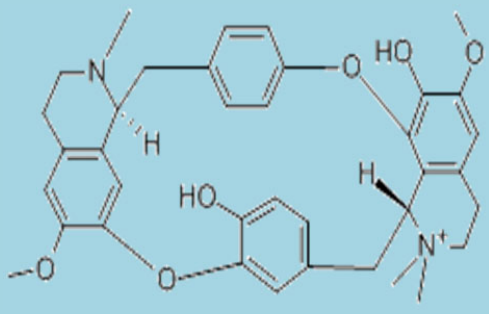
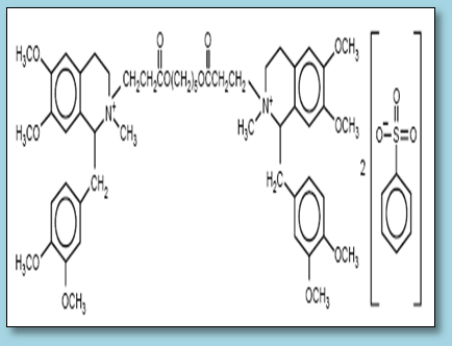
Figure 1. Structure of Theophylline and Aminophylline.

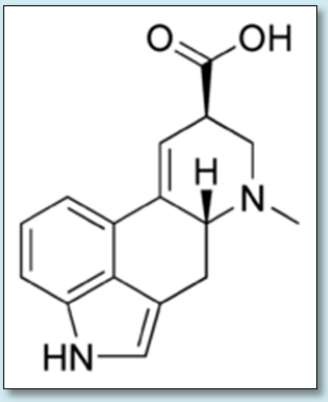
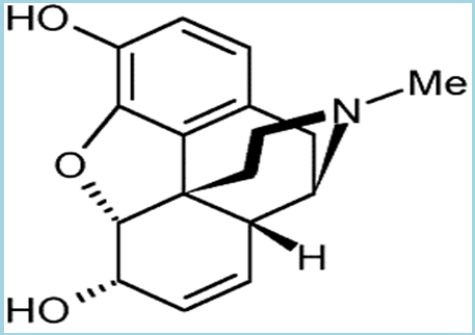
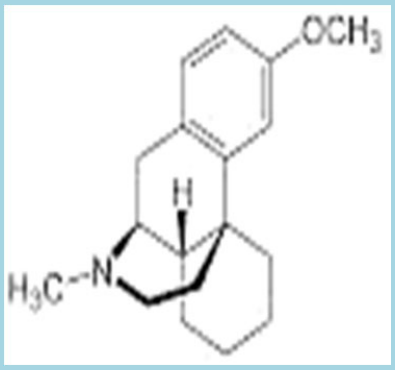
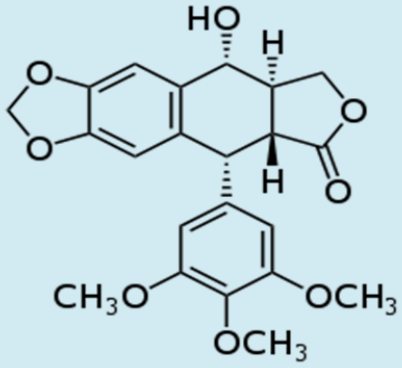
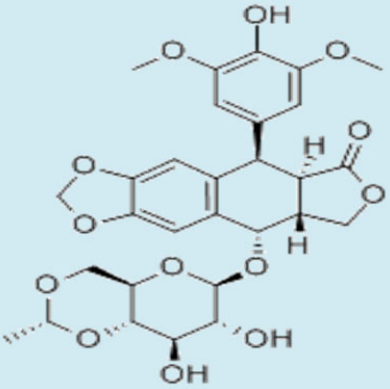
Morphine 6-glucuronide (M6G) is a modified form of Morphine, an important constituent of the dried latex (milky exudate) of *Papaver somniferum* (opium poppy). Morphine is the prototype of the opioid analgesics, being selective for μ receptors in the central nervous system that coordinate pain, M6G has fewer side effects than the morphine [4].

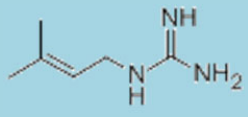
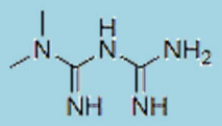
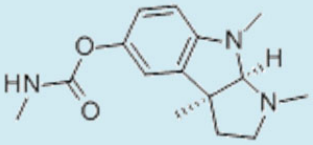
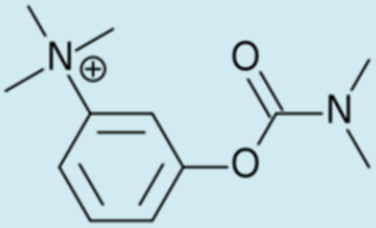
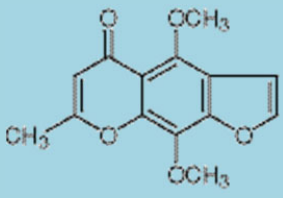
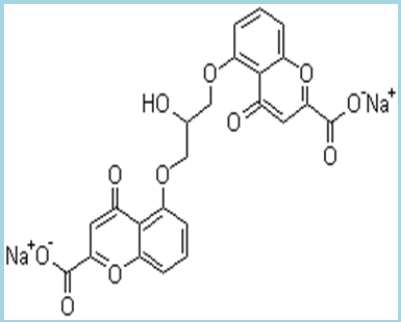
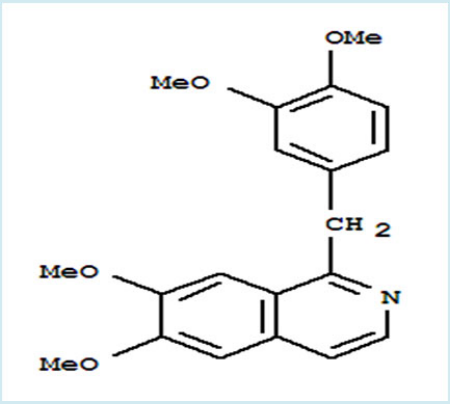
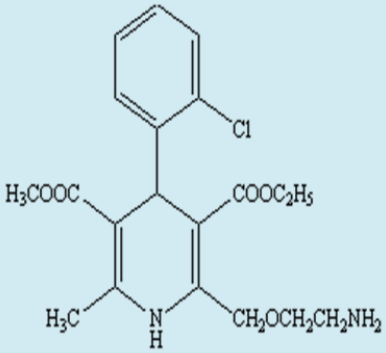
Template molecules of plant origin for synthetic drugs

Some of the purely isolated compounds obtained from plants are used as template molecules for synthesis of conventional drugs [11]. This has been illustrated under **(Table 2)**.

Table 2. Compounds from plant species that have served as template molecules for synthetic drugs.

Template molecule	**Synthetic analogue**	**Clinical use of synthetic analogue**
Tubocurarine from *Chondodendron tomentosum* 	Atracurium 	Muscle relaxant during anesthesia

Ergortamine from *Claviceps purpurea* 	Bromocryptine 	Treatment of Parkinson's disease
Morphine from *Papaver somniferum* 	Dextromethorphan 	Cough suppresant
Podophyllotoxin from *Podophyllum peltatum* 	Etoposide 	Anti cancer

Galegine from *Galega officinalis* 	Metformin 	Anti diabetic in Type 2 diabetes
Physostigmine from *Physostigma venenosum* 	Neostigmine 	Treatment of myasthenia gravis
Khellin from *Ammi visnaga* 	Sodium cromoglycate 	Anti asthmatic agent
Papaverine from *Papaver somniferum* 	Verapamil 	Treatment of Angina and cardiac arrhythmia

Challenges in drug discovery from plants

Although drug discovery from medicinal plants continues to provide an important source of new drug leads, numerous challenges are encountered including the procurement of plant materials, the selection and implementation of appropriate high-throughput screening bioassays, and the scale-up of active compounds [6].

Collection and identification of medicinal plants requires professionals who are able to correctly identify the species of the plant [12]. While most developing countries have scienitists needed for isolation and screening of compounds, the screening process is limited by inedquate technology even though medicinal plant resources are in abundance [3]. Structure determination of active principles of plants used in traditional medicine: extraction, separation and

determination of characteristics of active principles also pose challenges [13].

CONCLUSION

Medicinal plants are an important source of conventional medicines. The compounds can be used as isolated and purified compounds, modified or used template molecules to synthesize new conventional drugs. This remains true despite the continuing interest in molecular modeling, combinatorial chemistry and other synthetic chemistry techniques. This was a mini review and therefore examples highlighted in this article are not exhaustive. Efforts to conduct a systematic review of drugs derived from plants and challenges encountered is highly recommended.

DECLARATION OF CONFLICT OF INTEREST

The author declares no conflict of interest.

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