

## Pharmaceutical Importance of Naturally Biosynthesized Alkaloids in Plants

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### INTRODUCTION

Secondary metabolites naturally synthesized in the plant are the major source of pharmaceutical compound and therapeutic agents. Among the pharmaceutically active secondary metabolites, alkaloids are well known secondary metabolites biosynthetically derived from amino acid. Alkaloids synthesized in the plants are diversified class of secondary metabolites with pharmaceutical activities and also used for the treatment of different diseases (Van der Heijden, et al., 2004). These chemical entities have the potential to be used as an effective antioxidant, antimutagenic, anticarcinogenic and antimicrobial agents. Alkaloids that have antioxidant properties are capable of preventing a variety of degenerative diseases through capturing free radicals, or through binding to catalysts involved in indifferent oxidation processes occurring within the human body. Furthermore, the medicinal and aromatic plant species with alkaloids are likely to be included in the development of drugs, medicine and therapeutic agents. Moreover, in plant species approximately 20% alkaloids are found and protect plants from predators and regulate their growth. Recently, there is a resurgence of interest in bioactive natural products, driven both by a very proactive development in the field of traditional medicines (ethnopharmacology) as well as their potential in drug discovery (Atanasov, et al., 2021).

### Pharmaceutical application of plant alkaloids

Pharmaceutical use of plant alkaloids has a long history. Plants containing alkaloids have been used as medicine by human from last 3000 years. Plant alkaloids are largest class of secondary metabolites with respect to pharmaceutical and other medicinal point of view. Plant alkaloids have broad range of pharmaceutical activities like mutagenic or carcinogenic activity, antibacterial, antifungal, antiviral etc. (David, 1998).

Rather than medicinal use, some plant alkaloids (nicotine and anabasine) are used as insecticides. Protoberberine is one of the important plant alkaloids reported as analgesics, antiseptics, sedatives, and stomatics in Chinese folk medicine. In India and Islamic countries, plant alkaloids are used in bleeding disorder, eye diseases, antiseptics, sedatives, stomatics, and uterine muscle depressants. China used tetrahydropalmatine as an analgesic, which has been reported as bradycardial, hypotensive, and sedative activities (Leitao, et al., 2005).

Pharmaceutical activities of isoquinoline alkaloid extract from *Fumaria capreolata* as antioxidant, analgesic, and intestinal anti-inflammatory (Noureddine, et al., 2017). The alkaloids berberine isolated from *C. chinensis* exhibit antimetastasis effects on various types of cancers both *in vitro* and *in vivo*. The reports available from several studies, berberine has one of the important potential of anticancer by interfering with the multilayer aspects of tumor expression. In addition, berberines inhibit the proliferation of multiple cancer cells by inducing cell cycle arrest at the G<sub>1</sub> or G<sub>2</sub>/M phases and by apoptosis (Diogo, et al., 2011). However, berberine induces endoplasmic reticulum stress and autophagy in cancer cells. Berberine

also induces morphologic differentiation in human teratocarcinoma cells (Wang, et al., 2010). Berberine (isoquinoline alkaloid) has broad range of bioactivities such as antibacterial, antidiabetes as well as protection of myocardial ischemia-reperfusion injury and inhibition of platelet aggregation (Kulkarni, et al., 2010).

Aside from the aforementioned alkaloids, other diverse alkaloids like lycorine isolated from *Lycoris*, solanine isolated from *Solanum tuberosum* have anticancer potentials with diversiform mechanisms (Chen, et al., 2011). Some other alkaloids (camptothecin and vinblastine) have already been developed as anti-cancer drug. Moreover, the actions of plant alkaloids have been well described on immune system. It have also been found that number of inhibitory effects on the gene expression related to anti-inflammation, anti-proliferation, anti-system complementation, and others. The relevant action at digestive system level has also been reported as anti-diarrheic, electrolyte transport inhibition, and antiulcer activities. The pro-drug codeine metabolized by CYP<sub>2D6</sub> has analgesic effect of codeine and attribute towards its conversion into morphine (Korkina, et al., 2018). Major plant source of plant alkaloids and their pharmaceutical properties are given in table.

**Table: Plant source of alkaloids and their pharmaceutical properties**

| S. No. | Plant source                     | Alkaloids     | Pharmaceutical property            |
|--------|----------------------------------|---------------|------------------------------------|
| 1.     | <i>Atropa belladonna</i>         | Atropine      | Antidote to nerve gas poisoning    |
| 2.     | <i>Berberis vulgaris</i>         | Berberine     | Bacillary dysentery                |
| 3.     | <i>Colchicum autumnale</i>       | Colchicine    | Gout remedy                        |
| 4.     | <i>Coffea arabica</i>            | Caffeine      | Central nerve system stimulant     |
| 5.     | <i>Carapichea ipecacuanha</i>    | Ementine      | Antiprotozoal                      |
| 6.     | <i>Cinchona officinalis</i>      | Quinidine     | Antirhythmic                       |
| 7.     | <i>Chondrodendron tomentosum</i> | Tubocurarin-e | Muscle relaxant                    |
| 8.     | <i>Catharanthus roseus</i>       | Vinblastine   | Antitumor                          |
| 9.     | <i>Ephedra sinica</i>            | Ephedrine     | Antiasthmatics                     |
| 10.    | <i>Erythroxylum coca</i>         | Cocaine       | Anesthetic                         |
| 11.    | <i>Lobelia inflat</i>            | Lobeline      | Expectorants                       |
| 12.    | <i>Nicotiana tobacum</i>         | Nicotine      | Stimulant, nicotinic acetylcholine |
| 13.    | <i>Punica granatum</i>           | Pelletierine  | Anthelmintics                      |
| 14.    | <i>Pilocarpus pennatifolius</i>  | Pilocarpine   | Myotics                            |
| 15.    | <i>Papaver somniferum</i>        | Morphine      | Pain relief, diarrhea              |
|        |                                  | Noscapine     | Antitussive                        |

|     |                                 |              |                                     |
|-----|---------------------------------|--------------|-------------------------------------|
|     |                                 | Codeine      | Analgesic (Painkiller)              |
| 16. | <i>Rauwolfia serpentine</i>     | Ajmaline     | Antiarrhythmic                      |
|     |                                 | Reserpine    | Antihypertensive                    |
|     |                                 | Rescinnamine | Antihypertensive                    |
| 17. | <i>Rauwolfia canescens</i>      | Deserpidine  | Antihypertensive, tranquilizer      |
| 18. | <i>Sanguinaria Canadensis</i>   | Sanguinarine | Antibacterial, antiplaque activity. |
| 19. | <i>Vinca rosea, Vinca minor</i> | Vincristine  | Anticancer                          |
|     |                                 | Vincamine    | Vasodilating, antihypertensive      |

### CONCLUSION

Alkaloids are largest groups of secondary plant products on the earth with broad range of the pharmaceutical properties. Plant alkaloids are the natural gifts with number of pharmaceutical properties for certain life-threatening diseases in the human beings and animals. It has also been observed after the chemical analysis and research, that some of the alkaloids have harmful effects on the human body such as asphyxia, paralysis or in some extreme conditions can lead to the death. In this review, it has been concluded that alkaloids extracted from plant sources utilized for medicinal purposes to cure several severe disorders in human beings. Though, research and development in the field of plant derived alkaloids have been carried out from long but there are always further research areas from the pharmaceutical point of view in the plant alkaloids.

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