

Alkaloids in Biological System as drugs of the future

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Abstract: Alkaloids are natural compounds, produced by mostly plants, but not unique to plants, almost every class of organism produces alkaloids like fungi, bacteria, sponges, frogs, butterflies, moths, insects and mammals. These are a group of interesting and complex chemical compounds produced by the secondary metabolism of living organism. These are mostly nitrogen derivatives. Alkaloids play an important role in the ecology of organisms which synthesis them and specially in defence system against pathogens and animals. Alkaloids are actually metabolic waste but pharmacologically these are active compounds and supposed to be serving as a rich reservoir for drug discovery. Several alkaloids isolated from natural herbs exhibit antibacterial, antiviral, insecticidal, anti-proliferation and anti-metastatic effects that can be used to treat various diseases including malaria, diabetes, cancer, dengue, etc. Alkaloids are biologically significant as active stimulators, inhibitors and terminators of growth, as security and regulatory mechanism.

In this paper, attention has been drawn to know the significance of these wonderful metabolites which are not metabolic waste but are safety guards for the plants possessing them and drug for the human beings. Alkaloids are supposed to be starting point for drug discovery.

Keywords: Alkaloids, plant metabolites, growth regulators.

I. Introduction

The name Alkaloids (German Alkaloids) was introduced in 1819 by the German chemist Carl Friedrich Wilhelm Meilsner and is derived from latin root alkali meaning “ashes of plants” and the suffix like: - However, the term came in to wide use only after the publication of a review article, by Oscar Jacobsen in the chemical dictionary of Albert Ladenburg in the 1880. The term alkaloid is usually applied to basic nitrogenous plant products mostly optically active and possessing nitrogen heterocycles as their structural components.

Alkaloids are generally colourless crystalline and non-volatile liquids and are better and are better in taste. These are generally insoluble in water but soluble in organic solvents. Alkaloids have diverse and important physiological effects of humans and other animals. Well known alkaloids includes morphine; strychnine, quinine, ephedrine, and nicotine. Primarily alkaloids are present not only in human’s daily life in food and drinks but also as stimulants drugs.

It is estimated about 80% of the population of developing countries meet their primarily health care needs mainly through plants based traditional healing (Amin and Khan, 2016). Different parts of medicinal plants, rarely the whole plant of, are mostly used in the preparation of traditional medicines .for so many years, despite criticism; traditional healers provide immediate health care to the rural population, but also play an important role in providing leads to the discovery of pharmacology active plant-derived compounds (Butler, 2008, Khan and Rauf, 2014).

Alkaloids are produced by a large variety of organisms including bacteria, fungi , plants and animals . They can be purified from crude extracts of these organisms by acid –base extraction, or solvent extractions followed by silica gel column chromatography .Besides their medicinal uses , some alkaloids are toxic too for e.g. atropine obtained from atropine belladonna and tubocurarine. Alkaloid containing plants have been used by humans since ancient times for therapeutic and recreational purposes. The first alkaloid to be isolated and crystallized was the potent active constituent of the opium poppy, morphine, in about 1804.since then more than 1200 alkaloids have been isolated from different plants. A natural product that functions as a protective poison for the plant at a high concentration, is often a useful medicine for Homo sapiens at lower doses

Alkaloids and alkaloid –producing plants are specially well known for their toxic and sometimes psychomimetic , euphoric, and hallucinogenic properties . Consequently, several of them have known to mankind for several thousand years. A good subtitle for this chapter is “murder, magic and medicine,” the title of stimulating book of John Mann (1992).

Some important alkaloids produced by plants:

Name of the alkaloid	Name of the plant from which it is obtained	Uses
Morphine	<i>Papaver somniferum</i> (Poppy)	Powerful narcotic used for the relief of pain.
Cocaine	<i>Erythroxylum coca</i>	Antimalarial agent
Tubocurarine	<i>Chondrodendron tomentosum</i>	Muscle relaxant
Curare	<i>Chondrodendron tomentosum</i>	Skeletal muscle relaxant
Quinidine	<i>Cinchona</i>	Arrhythmias
Lobeline	<i>Lobelia inflata</i>	Antidepressant, respiratory stimulant
Ergonovine	<i>Fungus Claviceps purpurea</i>	Helps in Muscle contraction during child birth, checks excessive bleeding during child birth.
Strychnine	<i>Strychnos species</i>	Highly poisonous natural substance, stimulates CNS.
Psilocybin	<i>Psilocybe Mexicana</i>	Psychoactive hallucinogenic alkaloid.
Codeine	<i>Papaver somniferum</i>	Analgesic, antitussive
Nicotine	<i>Nicotiana tobaccum</i>	Stimulant, tranquilizer
Caffeine	<i>Coffea arabica</i>	Stimulant,
Vinblastine	<i>Catharanthus roseus</i>	Anticancer
Cocaine	<i>Erythroxylon coca</i>	Stimulant of central nervous system, local anaesthetic
Atropine	<i>Hyoscyamus niger</i>	Prevention of intestinal spasms, antidote to other poisons.
Camptothecin	<i>Camptotheca acuminata</i>	Anticancer
Serpentine, reserpine, ajmaline, ajmalicine	<i>Rauwolfia serpentina</i>	Antipsychotic, to treat mental illness, for hypertension
Withanolide D, Withaferin A	<i>Withania somnifera</i>	To treat insomnia, to boost nutrition, for pain relief and inflammation
Colchicine	<i>Colchicum autumnale</i>	Gout therapy
ephedrine	<i>Ephedra sinica</i>	For the treatment of low blood pressure, stimulant of CNS
Quinine,	<i>Cinchona calisaya</i>	Antimalarial drug
Piperine	<i>Piper longum</i>	Antiplatelet agent
Rutaecarpine	<i>Evodia rutaecarpa</i>	Antiplatelet activity
Spiramine	<i>Spiraea japonica</i>	Inhibit PAF induced platelet aggregation
veratroylgermine	<i>Veratrum dahuricum</i>	Antiplatelet activity
Beeta carboline	<i>Peganum harmala</i>	Antiplatelet activity
Romucosine D,C,A	<i>Rollinia mucosa</i>	Antiplatelet activity
leonurine	<i>Leonurus sibiricus</i>	Antiplatelet activity
Hernandaline	<i>Hernandia nymphaefolia</i>	Antiplatelet activity
Cucurmin	<i>Curcuma domestica</i>	Inhibitor of platelet aggregation
Aporphine	<i>Illigeralu zonensis</i>	Antiplatelet activity

Role of alkaloids in plants: The presence of alkaloids in plants enhances plant life by protecting them from biotic and abiotic stresses. Alkaloids can act as defence compounds in plants, being efficient against pathogens and predators due to their toxicity. Fast perception of aggressors and unfavourable environmental conditions, followed by efficient and specific signal transduction for triggering alkaloid accumulation, are key steps in successful plant protection. It is widely accepted that the main role of alkaloids in plants is toxicity against predators and pathogens. This toxic property observed in plants defence scenario can often be used in prospect

for new drugs. For example, a very specific toxicity may be used to fight certain tumor cell types, or also be used to control specific microorganisms or pests. Some plant alkaloids show allelopathic activity against target species in laboratory species. Demasi *et al.* reported the inhibition of *Lactuca sativa* and *Lepidium sativum* seedling growth by berberine, sanguinarine, and gramine, among other alkaloids, has been recorded. Additionally, alkaloids may act as growth stimulators and inhibitors in plants and as storage reservoirs of nitrogen. According to literature available, one of the sources of biostimulants are plant secondary metabolites. Plant extracts contain bioactive compounds capable of improving nutrient efficiency and increasing tolerance to biotic and abiotic stress (Bulgari *et al.* 2015), such as triterpenoid saponin (Andresen and Cedegreen, 2010), flavanoid (Prabhu *et al.* 2010) and alkaloids (Aniszewski, 2007). Alkaloids are versatile heterocyclic nitrogen compounds with reported antimicrobial activity against fungal or bacterial phytopathogens. Furoquinoline alkaloids, quinolizidine alkaloid extract, isoquinoline alkaloids (corynoline and acetylcorynoline), pyrrolizidine alkaloids have been mentioned as active compounds (Perez-Lainez *et al.* 2008). The multitarget mechanisms of action are represented by the outer membrane or cytoplasmic membrane disruption, respiratory inhibition, the Z ring perturbation, and nucleic acid synthesis/cell division inhibition (Bardin *et al.*, 2015; Cushnie *et al.* 2014). The plants in the human diet in which alkaloids are present are caffeine in coffee seeds, theobromine and caffeine in cocoa seeds, theophylline and caffeine in tea leaves, tomatine in tomatoes and solanine in potatoes. In today's scenario, when there is a great need to discover new drugs to combat new and more resistant pathogens, it is quite necessary to understand the detailed mechanism of alkaloid biosynthesis and mode of action, and to discover new bioactive molecules for successful exploitation of these bioactive molecules.

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