

# SIGMA

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A WEBZINE FROM THE DEPARTMENT OF CHEMISTRY

MAHESHTALA COLLEGE

Special Issue on: Natural Poison on Human Mankind

## ALKALOIDS

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*From the Editor's Desk.....*

*We all are acquainted with some common plants around us and sometimes use them as traditional medicine. But most of us might not have the knowledge about the chemical class to which they belong and the important compounds they possess. Their use in practice dose is beneficial to health but in excess, can be deadly. Since primitive age, our forefathers have taught us which fruits, flowers, seeds, barks & roots are poisonous and which ones are edible and which ones are used as primary medicine-the knowledge founded on their practical experiences.*

*Living in the age of advanced science we must have some scientific knowledge about this. Alkaloids is an important class of basic compounds, an important constituents of the plants, often used as an important medicine for treating diseases, sometimes even severe ones.*

*The structures of these alkaloids are very much complicated and difficult to be synthesized in the laboratory or industrially. But astonishingly, plants around us easily synthesize –the magic of biosynthetic routes!! Some of the alkaloids are used as narcotic drugs and are toxic for health. We, in the short span of the Webzine, have tried to give insight of some of the interesting aspects of this indigenous class of compounds. We hope to continue this Webzine with more interesting topics in future.*

## WHAT IS ALKALOID ?

- *Alkaloids represent a group of natural products that has a great influence etc.*
- *They are widely used to treat diseases ranging from malaria to cancer.*
- *Some alkaloids are extremely poisonous:*
- *Ergots alkaloids are poisonous*
- *The extracts of plants containing alkaloids have been used as arrow poisons in hunting and warfare.*
- *At the time of the Roman Empire, Belladonna has been mixed with food with the purpose of murdering.*
- *Cleopatra, the queen of Egypt, used Egyptian henbane that contains hyoscyamine, for suicidal purpose.*
- *Certain alkaloids are widely used for their psychotropic effects e.g caffeine acts as CNS stimulant.*

## HISTORY AND MYSTERY OF ALKALOIDS

*\*Human history shows alkaloids from plant extracts have been used as ingredients in potions (liquid medicine) and poison.*

*\*The extracts of plants containing alkaloids have long been used as arrow poisons in hunting and warfare.*

*\*Ancient people used plant extracts containing alkaloids for treating a large number of ailments including snakebite, fever and insanity.*

*\*In the Middle East, the latex of opium poppy seeds (Papaver) was already used in 1200 BC. Latex contains the alkaloids Morphine, Codeine. It was used as a pain killer.*

*\*It may be assumed that plants developed a wide variety of secondary metabolites defending themselves against herbivores, microorganisms, virus and pathogens*

*\*The functions of alkaloids in plants are yet not understood. Actually they are simply waste products of plant metabolic processes but they may serve specific biological functions.*

*\*In some plants the concentration of alkaloids increases just prior to seed formation and then drops off when the seed is ripe, suggesting that alkaloids may play a role in this process. Alkaloids may also protect some plants from destruction by certain insect species.*

*\*Alkaloids represent a group of natural products has a great influence on the economic, political, and social affairs of human beings.*

*\*The term "Alkaloid" (Alkali like) is commonly used to designate basic heterocyclic nitrogenous compounds of plant origin that are physiologically active.*

*\*The term alkaloid was coined by Meissner, a German pharmacist, in 1819.*

*\*The mankind has been using alkaloid for various purposes like poisons, medicines, poultices, teas etc.*

*\*In large doses - highly toxic fatal*

*\*In small doses - many have therapeutic value as muscle relaxants, tranquilizers, pain killers, mind altering drugs, chemotherapy.*



### **SOURCE OF NATURAL ALKALOIDS**

*\*Plants*

*\*Microorganisms*

*\*Bacteria, Fungus*

*\*Marine Organisms*

*\*Animal products*

### **CHARACTERISTICS OF ALKALOID**

*\*Alkaloids are usually colourless, crystalline, non-volatile solids, which are insoluble in water but soluble in ethanol, ether etc.*

*\* Most alkaloids have a bitter taste and are optically active*

## CHEMICAL CLASSIFICATION

Here, the alkaloids are classified according to the nature of heterocyclic ring, given with example.

**Pyrrolidine group** – Hygrine, Nicotine, Cuscohygrine

**Pyridine group** – Piperine, Coniine, Trigonelline, Nicotine, Arecoline, Arecaidine, Anabasin, Guvacine, Cytisine, Lobeline, Sparteine, Pelletierine.

**Quinoline group** - Quinine, Dihydroquinine, Quinolone, Strychnine, Quinidine, Brucine, Veratrine, Cevadine.

**Isoquinoline group** – Papavarin, Morphine, Codeine, Thebaine, Berberine, Emetine, Berbamine, Pancratistatin, Sanguinarine, Hydrastine.

**Indole group** – Lysergic acid, Vinblastine, Vincrostine, Yohimbine, Ergine, Ergotamine, Serotonin, Strychnine, Brucine, Harmine, Harmaline, Tetra hydro harmine.

**Phenanthrene group** – Morphine, Codeine, Thebaine, Oripavine

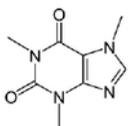
**Tropane group** – Atropine, Cocaine, Ecgonine, Scopolamine, Catuabine.

**Purine group** – Caffeine, Xanthines, Theobromine, Theophylline.

## Caffeine

**Plant:** Tea (*Camellia sinensis*) and others

**Use:** central nervous system stimulant



**Molecular formula:**  $C_8H_{10}N_4O_2$

**Molecular weight (g):** 194.2

**Toxicity (LD<sub>50</sub><sub>mouse</sub> mg/kg):** 62

**Cost per 100mg (£):** 1.25

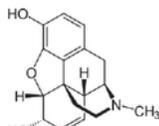
**Did you know?**

Plants like tea and coffee produce caffeine as an insecticide to poison bugs which try to feed on the leaves.

## Morphine

**Plant:** Opium poppy (*Papaver somniferum*)

**Use:** analgesic



**Molecular formula:**  $C_{17}H_{19}NO_3$

**Molecular weight (g):** 285.3

**Toxicity (LD<sub>50</sub><sub>mouse</sub> mg/kg):** 135

**Cost per 100mg (£):** 14.77

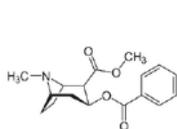
**Did you know?**

Laudanum, a potent painkilling medicine made from opium poppies, is documented as far back as 1522

## Cocaine

**Plant:** Coca plant (*Erythroxylum coca*)

**Use:** local anaesthetic, stimulant



**Molecular formula:**  $C_{17}H_{21}NO_4$

**Molecular weight (g):** 303.4

**Toxicity (LD<sub>50</sub><sub>mouse</sub> mg/kg):** 16

**Cost per 100mg (£):** 4.39

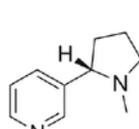
**Did you know?**

The original 1886 recipe for Coca-Cola included "a pinch of coca leaves" meaning, until 1906, it contained some cocaine!

## Nicotine

**Plant:** Tobacco (*Nicotiana tabacum*)

**Use:** stimulant, insecticide



**Molecular formula:**  $C_8H_{14}N_2$

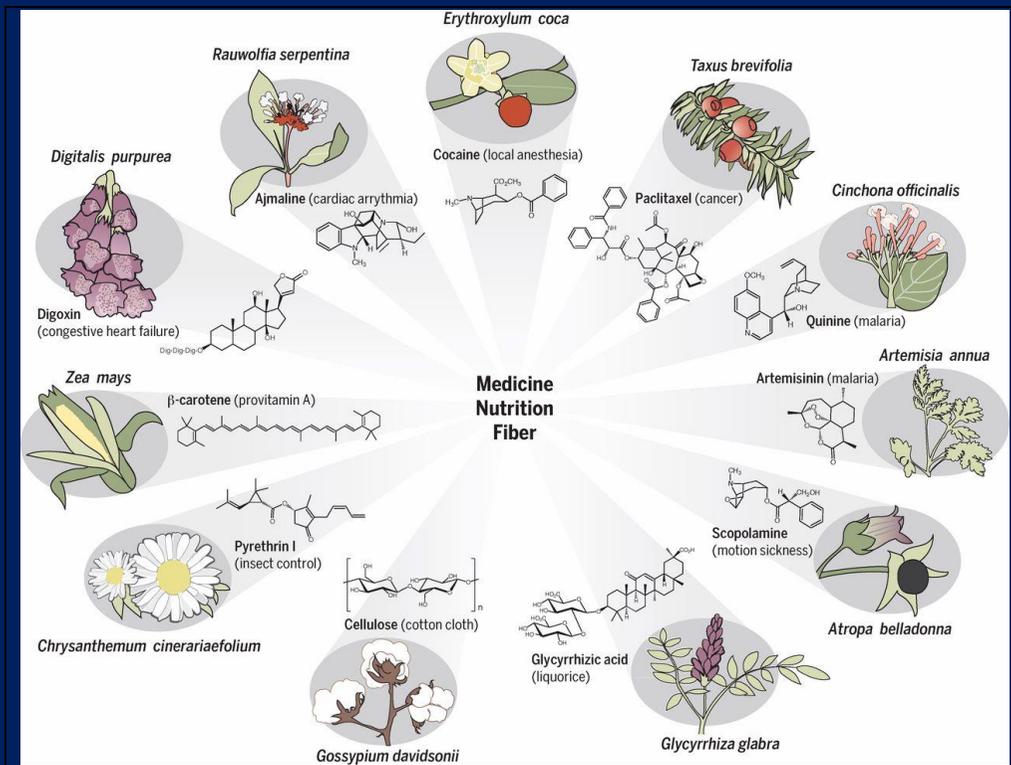
**Molecular weight (g):** 162.2

**Toxicity (LD<sub>50</sub><sub>mouse</sub> mg/kg):** 0.3

**Cost per 100mg (£):** 0.73

**Did you know?**

Nicotine is more toxic than cocaine or heroin and smoking 40 cigarettes could be deadly (not to mention silly!) for a non-smoker



## ALKALOIDS ARE NOT UNIQUE TO PLANTS

*Alkaloids bearing species have been found nearly in all classes of organisms: frogs, ants, butterflies, bacteria, sponges, fungi, spider's beetles and mammals.*

*\*some animals such as frogs produce toxic alkaloids in the skin.*

*\*Insects, use plant alkaloids as a source of attractants, pheromones and defence substances.*

*Poison Dart Frogs!!*





*Morphine Alkaloid Plant (Seed capsules with milky latex sap)*

### **ATROPINE**

ORIGIN: *Atropa belladonna*, *Datura stramonium*

\*The toxic alkaloid atropine comes from the highly poisonous Deadly nightshade, common name belladonna (Italian for “beautiful lady”)

Women placed atropine containing drops in their eyes to dilate their pupils, giving them a dreamy look that was believed to be attractive. Tragically, many of these women later became blind.



*Picture of Atropine Alkaloid Source (Datura Plant and seed )*



### Atropine Alkaloid

(In Egypt, queen Cleopatra used extracts to expand her pupils and appear more attractive.)

### COCAINE

It is an alkaloid obtained from the leaves of coca tree and is powerful addictive CNS stimulant

- Leaves when chewed have pleasant, pungent taste
- Poisonous parts : Leaves
- Grows throughout the tropical regions.(Latin America such as Columbia, Mexico, Ecuador and others countries such as Chile, Peru, India, SriLanka etc.)
- Cocaine is a bitter, white, odourless, crystalline drug
- According to the National Institute of Drug Abuse(NIDA), cocaine is “A Powerfully addictive drug that can be sniffed, injected, chewed or smoked”.



*Coca Plant*

## ACONITE

*\*diterpenoid alkaloid*

*\*Botanical origin: Aconitum napellus*

*Part used: roots*

*Action of drugs: antibiotic effect, analgesic effects, anti-inflammatory effects, antipyretic effects, cardiovascular effects.*

*It is distributed across North America and northern Asia.*



Aconite Plant: Flowers and Roots

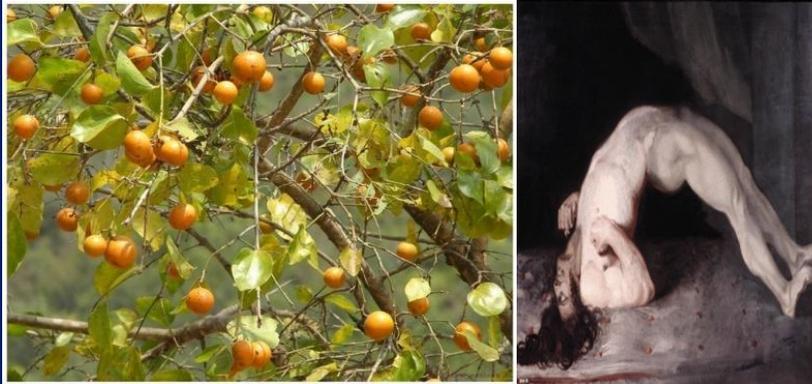
## STRYCHNINE

*One of the most deadly of known poisons. It is obtained from the seeds of strychnos nux-vomica. It causes excitation of all parts of the central nervous system.*

*It, when inhaled, swallowed, or absorbed through the eyes or mouth, causes poisoning which results in muscular convulsions, with a characteristic opisthotonus position with the back arched like a bow, as shown below.*

*The seeds of the ripe fruit are poisonous contains strychnine.*

*All parts of the tree are toxic.*



Strychnine plant. The characteristic opisthotonus position of the body on strychnine poisoning.

## **NICOTINE**

Nicotine is a pyridine pyrrolidine alkaloid found naturally tobacco plants.

Nicotine is extremely toxic as cyanide – and only 60 mg are needed to kill a human.

It is a hygroscopic, oily liquid that is miscible with water.

Most of the nicotine is burned when a cigarette is smoked. However, enough is inhaled to provide the desired effects.

Highly addictive



## QUININE



## CINCHONA TREE source of QUININE

Quinine is a well-known bitter anti-malarial drug occurring among the alkaloids of cinchona bark

Cinchona bark contains about 30 alkaloids, but its anti-malarial activity is mainly due to quinine

Quinine is a white crystalline, insoluble in water and has bitter taste.

- Antipyretic
- Analgesic
- Anti-inflammatory
- Antimalarial

## CONIINE

\*The piperidine alkaloid Coniine is a colourless oily liquid, with mice like odor and a burning taste. It is used as a local analgesic, mostly in external preparations, due to its high toxicity.

\*Occurrence : The hemlock fruits, *Conium maculatum*.

\*Coniine is extremely toxic, causing paralysis of motor nerve endings.

\*\*"The Death of Socrates" \_ the philosopher Socrates drank and extract of Coniine –containing poison Hemlock (399 B.C)



alamy stock photo

616177  
www.alamy.com

The poison hemlock is the killer of Socrates : is a dangerous plant that grows throughout the United States. The plant has white flowers that grow in clusters, and the stem has purple spots.

## HEMLOCK PLANT

### *RESERPINE*

*It is an indole alkaloid obtained from the roots of Rauwolfia serpentina (Sarpagandha)*

*Reserpine is the main constituent of Rauwolfia serpentina.*

*It is mainly used for the treatment of hypertension, headache, tension, asthma & dermatological disorders.*



SARPAGANDHA (*Rauwolfia serpentina*)

**CAFFEINE** - Purine alkaloid

*The most common sources in our diet are coffee, tea leaves, coffee beans.*

*Pure caffeine is odourless and has a bitter taste.*

*In Japan researchers have shown that caffeine increases memory.*

*Some physiological effects associated with caffeine administration include central nervous system stimulation, acute blood pressure, increased metabolic rate and diuresis.*

*Caffeine is rapidly almost completely absorbed in the stomach and small intestine and distributed to all tissues, including the brain.*



*Coffee Plant makes caffeine to defend themselves against pests. Caffeine is toxic to birds, dogs, cats, and various insects and spiders.*

**VINCA ALKALOIDS**

*Source :Madagascar periwinkle plant( Catharanthus roseus )*

\*Ornamental plant as well as medicinal purpose.

\*Propagate by seeds or by stem cutting.

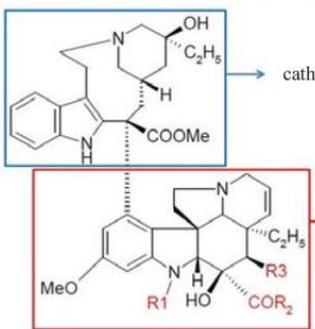
\*evergreen shrub growing to 1 m tall.

\*Both compounds commonly used for cancer therapy and has its anti-diabetic property, anti bacterial and anti oxidant property.

\* Vinblastine and Vincristine are two anti cancer drugs in use.

Region: Australia, South Africa and Asia. In India, It is mostly found in Tamil Nadu, Karnataka, Gujarat, Odisha, West Bengal and Andhra Pradesh.

(A) 

(B) 

Taxa	
Kingdom	Plantae
Phylum	Magnoliophyta
Class	Magnoliopsida
Order	Gentianales
Family	Apocynaceae
Genus	<i>Catharanthus</i>
Species	<i>C. roseus</i>

*Catharanthus alkaloids* :Pharmaceutically important terpenoid indole alkaloids shows anti leukaemic activity and also used in folk medicine as an antidiabetic and to relieve pain from a sore throat, laryngitis , chest complaints(gargling with an infusion of the plant). Juice squeezed from the leaves is applied to wasp stings in India.



*Vincristine alkaloid : Life –saving DRUG (anti cancer drug ) from a periwinkle plant ( In West Bengal : Nayan Tara )*

A few words at the end.....

In nature there are so many natural compounds. From among many classes of naturally occurring organic compounds such as carbohydrates, lipids, proteins, amino acids, anthocyanins, flavonoids, and steroids, the one that seems to be quite special is alkaloids. What makes them special?

These compounds play an important role in living organisms. They show strong biological effects on animal and human organisms in very small doses. They showed anti-inflammatory, anticancer, analgesics, anti-microbial, anti-fungal, local anesthetic and pain relief and many other activities.

This Webzine has sought to provide an overview of alkaloid drugs that are derived from Nature & their potential use to fight diseases and yet how they themselves can become fatal on overdose...A short journey into the overwhelming mysterious world of alkaloids.....

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