

CHM 320 – PESTICIDE CHEMISTRY

The term pesticide refers to toxic/poisonous chemicals which are used directly or indirectly against pests or insects in order to eradicate or control such pests. Pesticidal compounds are often used in the control of pests and diseases of plants and to control of micro-organisms and other microbes that disturbs the growth and productivity in plants. They are generally known to be toxic.

Pesticides include:

1. Insecticides – used against insects
2. Herbicides – used against weeds
3. Rodenticides- used against rodents
4. Bacteriocides – used against bacteria
5. Nematocides – used against nematodes
6. Molluscicides – used against mollusk
7. Nematocides – used against nematodes
8. Algicides- used against algae
9. Fungicides –used against fungi.

Importance of Pesticides

Since historical time, there were concerted efforts by man to produce food for the ever growing world's population. In spite of the rapid technological development, still the end has not justified the means in the area of food production. The report of World Health Organization indicated that a third of the population of the world suffer from hunger and malnutrition. This is because agricultural production faces some problems emanating from invasion by pests, weeds, microbial infections, etc. Pests equally attack stored grains, tubers, to the extent that they cause a lot of damage. A complete elimination of the problem above was achieved through by integrated pests management which includes quarantine, agro technical, mechanical, biological and chemical methods. The chemical methods of protecting agricultural products as well as the animals was based on the use of various organic and inorganic compounds which are synthesised and are known to be toxic to pests invading plants and animal outreach. It is important to note that pesticides cannot increase the plant yield, but have ability of eliminating pests that can impair plant growth. The use of pesticides started after the Second World War.

Historically, the earliest pesticidal compound ate mostly inorganic compounds such as CuAs_2O_3 (copper arsenate), sulphur compounds as well as naturally-occurring rotenone and pyrethroids. CuAs_2O_3 has been used to eradicate colorab that infects tomato while sulphur compounds are used as insect repellants. After this, then comes natural pesticides; some were obtained from plant extract e.g. nicotine obtained from tobacco

leaves; pyrethroids obtained from pyrethrin flowers. Then come synthetic pesticide which includes:

1. Organochlorine pesticides;
2. Organophosphorous pesticides;
3. Organocarbamates and
3. Synthetic Pyrethroids.

Reasons for the obsolescence of pesticides

Generally, majority of used insecticides often turns obsolete and functionless after some time, due to some peculiar problems associated with them. Some of this issue has to do with the adaptability of some organisms to environment. The toxic nature of some chemicals to animate and inanimate substances led to their total ban and usage, especially those that have genetic effects such as genetic mutation.

Development of new pesticides that is cheaper and less hazardous to the applicant, consumer or even the environment. High specificity and selectivity of these chemicals to the environment is another factor in favour of new insecticides produced on regular basis.

Properties or characteristics of pesticides

1. They are toxic and therefore constitute pollutant materials into the atmosphere e.g. organochlorine pesticides;
2. Most pesticides have simpler structure, with simple biological activities.
3. Each pesticide has a lethal dose (LD₅₀)
4. Each pesticide has chemical intermediate, which often get obsolete after some time.

Regulations on the use of pesticides

As a result of the toxic and hazardous nature of most pesticides to animals and inanimate substances, when disposed carelessly, regulations on the use of pesticides have been enacted. Regulatory bodies such as Federal Environmental Protection Agency (FEPA) in Nigeria have enacted laws to regulate the use of pesticides. The law has to do with the need to protect the operators and the public against dangerous effects of pesticides or effects of the residues of some pesticides. The law involves complete banning and shipping of certain pesticides to and fro Nigeria. It equally involves standardization of manufactured chemicals and protection of the consumers of finished products. The same regulation includes a provision that protects the supplier of toxic chemicals, application of toxic chemical and other personnel proximal to the use of pesticides.

Classification of pesticides

Generally, pesticides are classified into natural and synthetic ones.

1. Natural Pesticides include Pyrethroids, Nicotine and Rotenones

2. Synthetic Pesticides include Organochlorines, Organophosphorous, Organocarbamates and Synthetic Pyrethroids.

Various methods have been used to classify pesticides, as shown below:

1. Classification based on intended use or the target organisms;
2. Classifications based on the chemical nature of pesticide or simply on the chemical compositions. Chemical classification of pesticides is in three categories viz:
 - (a). Inorganic compounds such as sulphur and CuAs_2O_3 , mercury and ;
 - (b). Natural pesticides or botanical pesticides-are those derived from vegetable plants, bacteria of from fungi preparation
 - (c). Synthetic organic compounds such as Organochlorine, Organophosphorous, Organocarbamates and Synthetic Pyrethroids .
3. Classifications based on the mode of action – this depends on how the poison penetrates or permeates into the body of the pests and consequently knocking it down. Some sub- classification under this are enumerated below:
 - (a). Stomach poison pesticides: acts by poisoning insects when swallowed and digested with the food;
 - (b). Contact poison insecticides: acts by poisoning the insect when in contact with the skin;
 - (c). Fumigants: acts by penetrating the organisms through respiratory tracts in the form of gas or vapour. They are basically vapour phase chemicals and are usually applied as aerosols.

The stomach and fumigant pesticides are generally called systemic chemicals.

Important Characteristics of Pesticides

An ideal pesticide possesses two major characteristics viz:

- (a). Specificity: an ideal pesticide must be specific in its action, that is it should attack only the targeted species or organisms or pests;
- (b). Non-persistent: an ideal pesticide must be readily degraded in the environment within few days or weeks and should not partition into the adipose tissue or leaves residues that impair ecosystem.

Generally, ideal pesticidal compounds must be cheaper, have low toxicity to applicants and should be easy to apply.

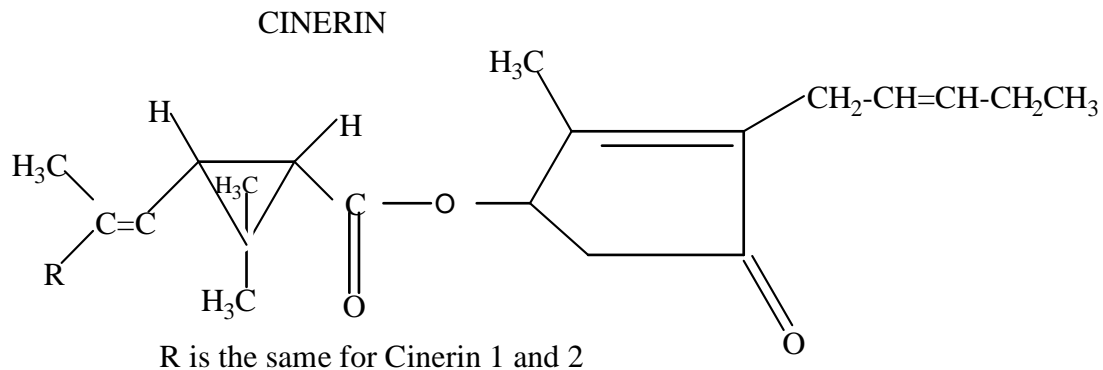
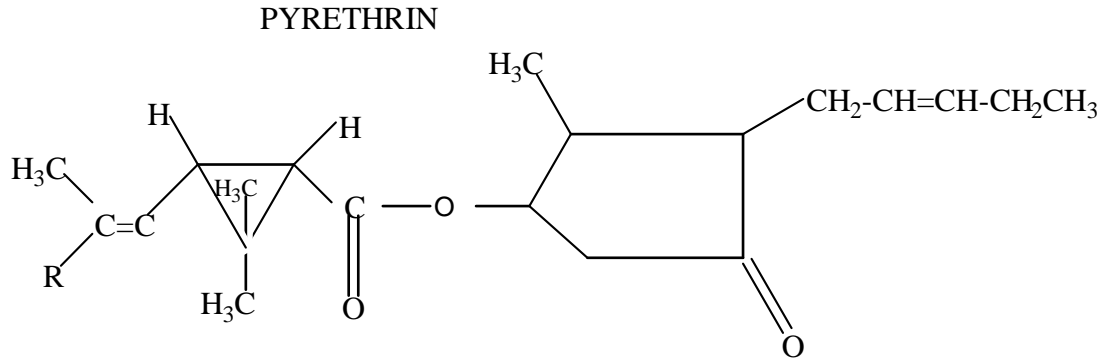
Natural Pesticides

An example of natural pesticides, also called botanical pesticides is pyrethroid. It is extracted from pyrethrum plant using petroleum ether or acetone. Natural pesticides are often characterised by a reasonable knock-down effect of flies. Often, they are used as domestic spray against flies and mosquitoes. They have extremely low toxicity on warm-blooded animals. They are less persistent to the environment because they are rapidly destroyed by light, and are said to be photodegradable. They are contact poison pesticide and

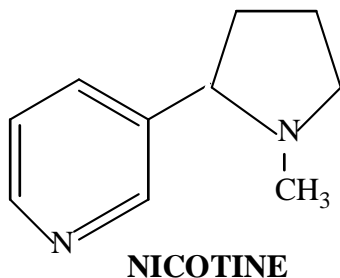
are equally neurotoxic. Generally, pyrethroids are broad spectrum insecticide, hence they eradicate beneficial insects.

Chemistry of Natural Pesticides

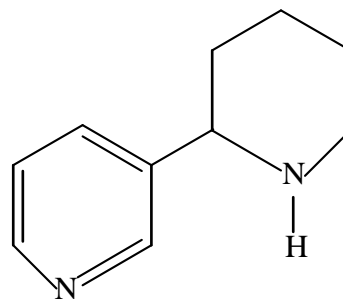
Basically, natural pesticides contain four principal ingredients known as pyrethrin 1 and 2, and cinerin 1 and 2.



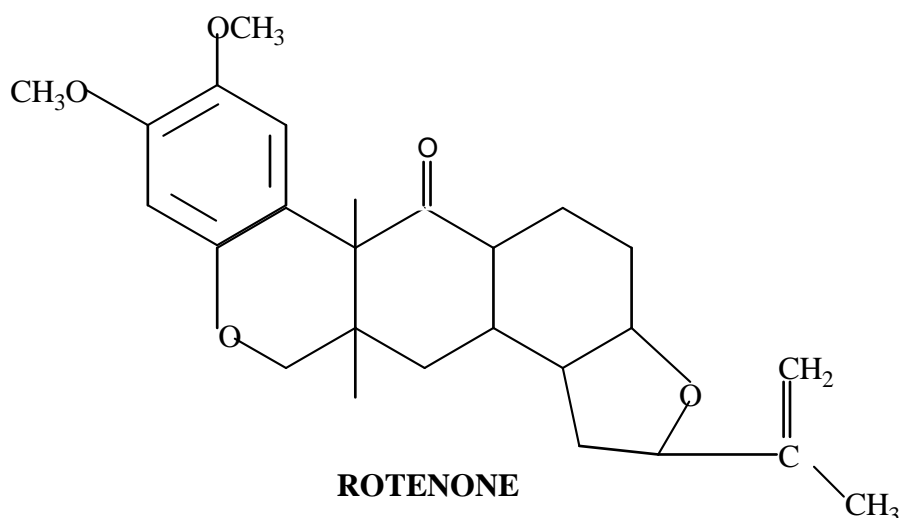
Other examples of natural pesticides are Anabasine, Nicotine and Rotenone



NICOTINE



ANABSINE



ROTENONE

SYNTHETIC ORGANIC INSECTICIDES

Organochlorine Insecticides

A common feature of all organochlorine insecticide/compounds is the presence of chlorinated carboxylic ring in the structure of the molecule. Another peculiar feature of organochlorine is their low water solubility (hydrophobicity) hence they are strongly lipophilic. Consequent upon their solubility, they are often retained in body fat and as such, they are rarely degradable into extractable water, hence they are accumulated in the adipose tissues. They are generally known as bio accumulator. Organochlorine compounds are waxy at room temperature. Common example of organochlorine pesticides is dichlorodiphenyltrichloro ethane (DDT). Its IUPAC name is 1,1,1-trichloro-2,2-bis-p-chlorophenyl ethane.