CHAPTER I

ABOUT CYPERMETHRIN


**Cypermethrin:**

**Chemical structure and properties insecticide**

Cypermethrin (CYP) is a pyrethroid insecticide, widely used in agriculture and environmental applications. It is used in India and other countries. It was first marketed in 1977 (WHO, 1989). It has been classified as class II in toxicity. In mice the oral LD$_{50}$ value of technical grade CYP of is 250 mg/kg when administered in corn oil (Ray 1991; US EPA 1989) and 657 mg/kg body weight when administered in aqueous suspension (Rose, 1982; WHO, 1989).

1. **Technical cypermethrin:**

Technical cypermethrin is a mixture of eight different isomers, each of which may have its own chemical and biological properties. CYP is light stable. It is available as an emulsifiable concentrate or wettable powder. The primary manufacturers of CYP in the U.S. are Zeneca Inc., FMC Corp., and American Cyanamid Co. Common brand names are Demon, Cymbush, Ammo, and Cynoff (WHO, 1989). All of the insecticides in this family have chemical structures that are loosely based on pyrethrins, insecticidal compounds found in chrysanthemum flowers (Casida, 1980). Most synthetic pyrethroids are complex molecules; and cypermethrin (CYP) is no exception. Because of its complexity, there are eight different ways that the atoms that make up the CYP molecule can arrange themselves in three dimensions. These are called isomers.
2. **Chemical structure:**

   ![Chemical structure diagram]

3. **IUPAC nomenclature:**

   \[(RS).-\alpha\text{-cyano-3-phenoxybenzyl}(1RS).-\text{cis\,-\,trans-3(2,2\text{-dichlorovinyl})\,-\,2,2\text{-dimethylcyclopropane carboxylate}} \text{ (WHO, 1989).}

   **Molecular weight:** 416.30

   **CAS Registry No.:** 52315-07-8

   **PC Code:** 109702

4. **Physical properties (WHO 1989):**

   - **Color:** Yellow
   - **State/Form:** Varies from a viscous yellow liquid to a semi-solid crystalline mass at ambient temperatures
   - **Melting Point:** 60-80 °C
   - **Boiling Point:** 216 °C
   - **Density:** 1.204 g/mL at 25°C
   - **Vapor Pressure:** 3.1E-9 mm Hg at 20 °C
   - **Water Solubility:** 7.6 ppb at 25 °C
   - **Log P (octanol-water):** 6.60
Solubility:

Solubility in water (20°C) is 0.009 mg/liter and for organic solvents, hexane 103 g/liter, xylene greater than 450 g/liter and also comparable solubility in cyclohexane, ethanol, acetone, and chloroform (WHO, 1989).

Stability:

Highly stable to light at temperatures below 22 °C. More resistant to acidic than to alkaline media, with an optimum stability at pH 4. Dilute aqueous solutions are subject to photolysis which occurs at a moderate rate (WHO, 1989).

5. Principal trade names of cypermethrin:


Molecular formula: \(C_{22}H_{19}O_3NCl_2\)

6. Routes of entry

Oral:

Cypermethrin is rapidly absorbed from the gastrointestinal tract.

Inhalation:

Human poisoning cases have been reported following exposure to air from contaminated air-conditioning ducts.
Dermal:

Dermal absorption has been demonstrated in human volunteers.

Eye:

No data available but is possible in view of dermal exposure.

7. Mode of action:

The major target site of cypermethrin is the sodium channel of the nerve membrane. A sodium channel exposed to cypermethrin can remain open much longer, even up to several seconds (He, 1994) resulting in impairment neurotransmission.

8. Kinetics and metabolism

Studies in rats have shown that CYP is rapidly metabolized by hydroxylation and cleavage with over 99% being eliminated within hours. The remaining 1% becomes stored in the body fat. This portion is eliminated slowly with a half-life of 18 days for the cis-isomer and 3.4 days for the trans-isomer (Ray, 1991; Crawford and Huston, 1977). In humans, urinary excretion of CYP metabolites was complete 48 h after the last of five doses of 1.5 mg/kg/day (Ray, 1991). Absorption of cypermethrin from the gastrointestinal tract and its elimination are quite rapid. The major metabolic reaction is cleavage of the ester bond. Elimination of the cyclopropane moiety in the rat over a 7-day period ranged from 40 to 60% in the urine and from 30 to 50% in the faeces; elimination of the phenoxybenzyl moiety was about 30% in the urine and 55 to
60% in the faeces. Biliary excretion is a minor route of elimination for the cyclopropane moiety and small amounts are exhaled as carbon dioxide. In principle, these absorption and elimination rates and metabolic pathways hold for all animal species studied, including domestic animals. Consistent with the lipophilic nature of cypermethrin the highest mean tissue concentrations are found in body fat, skin, liver, kidneys, adrenals, and ovaries. Only negligible concentrations are found in the brain. The half-life of cis-cypermethrin in the fat of the rat ranges from 12 to 19 days and that of the trans-isomer from 3 to 4 days. In mice these half-lives are 13 days and 1 day respectively (WHO, 1989).

9. Uses

CYP has been used for several years against many pests (particularly Lepidoptera, cockroaches, and termites). It is used in agriculture, animal breeding and the household including moth pests of cotton, fruit, and vegetable crops. It is also used for crack, crevice, and spot treatment to control insect pests in stores, warehouses, industrial buildings, houses, apartment buildings, greenhouses, laboratories, and on ships, railcars, buses, trucks, and aircraft (US. EPA, 1989) and veterinary ectoparasites (Oheme and Mannala, 2001). It may also be used in non-food areas in schools, nursing homes, hospitals, restaurants, hotels, in food processing plants, and as a barrier treatment insect repellent for horses (Elliot and Janes, 1978; WHO, 1989; Luty et al., 2000). After household treatments, CYP persists in air and on the walls and furniture for about three months (Cox, 1996).
10. **Toxic effects**

CYP is one of the compounds extensively used as it has a wide margin of safety in mammals (Khan *et al.*, 2008). In spite of a wide margin of safety CYP is not free from side-effects. Toxicity of CYP in farm animals can occur through spray/dipping or ingestion or through the ingestion of sprayed crops/fodders. It was found that CYP has an adverse health effects such as neurological or psychological disorders, irritation of skin and mucous membranes, skin disorders, impaired immunity, difficulty in breathing, dizziness, headache, fatigue, transient changes in EEG, signs of restlessness, mild disturbance of consciousness and coma. These effects depend on the degree of exposure (He *et al.*, 1989; He, 1994).

These verity of the effects of pyrethroids are influenced by route of exposure, vehicle and dosing volume (Bradbury and Coats, 1989; Soderlund *et al.*, 2002). Introduction of the compound into the brain is most toxic, followed by introduction into blood vessels, gut (intraperitoneum), oral, inhalation, and dermal (skin) exposure (Bradbury and Coats, 1989). CYP suppresses cell-mediated as well as humoral immunity (WHO, 1989).