THINGS YOU NEED TO KNOW ABOUT PESTICIDES

What exactly is a Pesticide?

Pesticides include **insecticides**, herbicides and fungicides, which are designed to kill insect, weeds and diseases respectively. Formulated pesticide products contain both active and inert ingredients. Active ingredients kill or control the pest(s) the product is designed for, while inert ingredients are designed to preserve the active ingredients, make them easier to apply or improve their killing ability. Examples of inert ingredients currently found in conventional household insecticides are solvents, carriers, etc.

All pesticides are, by definition, toxic to some living thing – insecticides to insects, herbicides to plants, fungicides to fungi, and so on. In addition, they often have direct or indirect effects on other living things.

Synthetic pesticides are chemical compounds invented in a laboratory. Some are more toxic than others; some are longer lasting than others, and some release compounds that are more toxic than the original pesticides when they break down in the environment. Some accumulate in the environment and cause harm far removed from the original site or purpose of application. Others, called persistent materials, just “hang around” and don’t break down for long periods of time.

Botanical pesticides, almost all of which are insecticides, are derived directly from plants or animals. All botanicals break down rapidly in the environment, usually in a matter of hours or days, and are not known to accumulate in the environment.

According to the World Health Organization (WHO) and the Environment Protection Agency (EPA) of the United States of America, no pesticide can be considered “safe”. But, because of the effects on other living things, some are safer to use than others. Before selecting a pesticide, be an informed consumer and use environmental common sense when using pesticides in your home and garden.

Insecticides

Household insecticides were purportedly developed for hygienic purposes and for safe indoors use. But, how safe are conventional insecticide formulations for

normal use and, is there an easy way to know how dangerous a chemical or active ingredient might be?
In most countries (including Singapore), the Law requires that all insecticides must have labels providing an extensive amount of information and indications that the insecticide has been extensively tested, evaluated and regulated by the appropriate government authority. In addition, the active ingredient must be clearly identified by one of three signal words: ***Danger, Warning or Caution***. These signal words help alert users to special hazards of a pesticide product by indicating its level of toxicity to people, based on the most hazardous way to be exposed – the routes of exposure can be through inhalation, ingestion; dermal absorption or contact with the eye or skin.

Danger is the most highly toxic and is sometimes also labeled as poison. ***Warning*** applies to moderately toxic chemicals and ***Caution*** refers to those chemicals that are considered fairly safe for people.

Information on inert ingredients is not required on a product's label because this information is considered proprietary. These ingredients typically comprise between 80 – 90% of a pesticide, and in some cases can be more toxic than the active ingredients.

Regardless of the signal word of a pesticide product, it is important to remember that almost every insecticide product are hazardous if misused, no matter what its toxicity. While we do not have control of the toxicity of a pesticide (since toxicity is a given characteristic of a particular pesticide), we can, however, have control over our exposure to pesticides. Every time a pesticide product is used, special care should be taken to carefully follow all the directions on the label – as ultimately, it is the users who will have to assume the risks of potential chemical injury when they select to use a particular insecticide around their homes.

Exposure and Toxicity

The risk(s) of potential chemical injury from pesticides can be minor or deadly, depending on the toxicity of the pesticide used. **(Toxicity x exposure)** is the equation used to determine the risk involved when using a pesticide.

The effects of an insecticide on human health and the environment depend on how much of the chemical is present and the length and frequency of exposure. Effects also depend on the health of a person and/or certain environmental factors.

Children and individuals with impaired immune systems are more vulnerable than adults to pesticide poisoning. Children have higher metabolic rates, and

absorb higher concentrations of toxins from the environment than adults. In addition, children have not fully developed their body's defense systems against toxins. Their livers and kidneys, the organs that detoxify and excrete foreign substances, and act as barriers to absorption of toxic substances, have not fully developed.

It cannot be over-emphasized that all pesticide users should take the necessary precautions to limit their exposure and to handle pesticides in a safe manner to avoid risking their own and their family's health, the environment and the wildlife around them.

Toxicity

Simply put, toxicity is the property of a chemical that causes damage to the body of a living organism.

Acute Toxicity

Acute (short-term) toxicity – which refers to the toxicity of the chemical after a single or limited exposure – is the basis for pesticide classifications on product labels. Acute toxicity means there will be immediate effects to an exposure in a short period of time.

Chronic Toxicity

It is also important to be aware of chronic toxicity – the measurement of the amount of a pesticide that will cause injury during repeated exposures over a period of time. The effects associated with chronic toxicity include birth defects, nervous disorders and benign or malignant (cancerous) tumors.

One of the most widely occurring types of chronic toxicity is cholinesterase inhibition. Cholinesterase is a chemical produced by the body that controls nerve impulse transmission. If cholinesterase were absent, impulses from one nerve to the next would flow continuously. Prolonged exposure to organophosphates and carbamates pesticides inhibits cholinesterase from controlling the impulses described above. These compounds are commonly called cholinesterase (ch) inhibitors.

Interpreting Toxicity

Subjecting test animals to different dosages of the active ingredient through the skin (dermal), breathing (inhalation), or mouth (oral) determines the toxicity of a pesticide.

The current standard used by the **World Health Organization's Pesticide Evaluation Scheme (WHOPES)** is to measure the acute toxicity of all known active ingredients and express the toxicological data in the form of LD_{50} (lethal

dose) values. LD_{50} represents the potency of a chemical substance – the dose in milligrams (mg) of chemical per kilogram (kg) of body weight that causes death (resulting from a single or limited exposure) in 50 percent of the treated animals. Toxicity increases as the LD_{50} value decreases. Small LD_{50} values are big troubles - the lower the number, the less of that substance is required to kill an animal.

Safety Comparison / Toxicity Category of common household insecticides

(Source: The WHO Recommended Classification of Pesticides by Hazard, 1996-1997)

Insecticide	**LD_{50} mg/kg (Rats)**	**WHOPES Classificatiion**	***Signal Word***
Chlorpyrifos	135	Class II Table 3	Moderately Hazardous ***(Warning)***
Cyfluthrin	250	Class II Table 3	
Cypermethrin	250	Class II Table 3	
DDT	113	Class II Table 3	
Deltamethrin	129	Class II Table 3	
Permethrin	500	Class II Table 3	
Prallethrin	460	Class II Table 3	
Propoxur	95	Class II Table 3	
Malathion	1,375	Class III Table 4	Slightly Hazardous ***(Caution)***
Primiphos-methyl	2,018	Class III Table 4	
ETOFENPROX**	**>10,000**	Table 5	Unlikely to present acute hazard in normal use ***(Caution)***
Lambda-cyhalothrin (Tetramethrin)	>5,000	Table 5	
Transfluthrin	>5,000	Table 5	
Sodium Chloride (Table Salt)	3,000	NIL	NA
Sucrose (Cane Sugar)	29,700	NIL	NA

*****ETOFENPROX** has been tested (test data available upon request) to LD_{50} > 42,880 mg/kg. Test procedures were stopped after scientific opinion that further tests would be unnecessary.*

ENVIRONMENTAL IMPACT

The 3 important properties of pesticides, which determine their fate and behaviour in the environment, are persistence, volatility, and solubility in water.

When pesticides are released into the environment, they are either:

1) broken down, or degraded, by the action of sunlight, water or other chemicals, (photodegradable) or micro-organisms such as bacteria (biodegradable); or

2) resist degradation and thus remain unchanged in the environment for long periods of time.

Persistence

The persistence of a pesticide is its ability to remain unchanged. Persistence is measured by half-life. The half-life is the time it takes for half of the initial amount of a pesticide to breakdown. Thus, if a pesticide's half-life is 30 days, half will be left after 30 days, one-quarter after 60 days, one-eighth after 90 days and so on.

Half-life is the time required for half of the compound to degrade.
1 half-life = 50% degraded
2 half-lives = 75% degraded
3 half-lives = 88% degraded
4 half-lives = 94% degraded
5 half-lives = 97% degraded
Note that the amount of chemical remaining after a half-life will always depend on the amount of the chemical originally applied.

When the pesticide is broken down, this usually leads to the formation of less harmful products. However, in some instances the products can be more toxic than the original pesticide.

Pesticides that are easily broken down generally move the shortest distance and have the least adverse affects on people or other organisms. Persistent pesticides generally move the longest distances and have the greatest potential to accumulate in living organisms.

Volatility

The volatility of a pesticide is its ability to evaporate. Pesticides that are more volatile have the greatest potential to go into the atmosphere. If they are persistent, they can move long distances.

Solubility

The solubility of a pesticide is its ability to dissolve. If a pesticide is very soluble in water, it is more easily transported by rainwater as runoff, or through the soil as a potential groundwater contaminant. Water-soluble pesticides are more likely to remain in the surface water where they may adversely affect fish and other organisms.

Properties of the Environment

The individual properties of soil, water and living organisms affect the fate and

behavior of pesticides. Climate and topography also play a role. Soils vary in their ratios of sand, organic matter, metal content, acidity, porosity, permeability, etc. These soil characteristics influence the behavior of pesticides. Water characteristics also vary and influence pesticide behavior. Some of the characteristics are acidity, depth, temperature, clarity, flow rate, presence of biological organisms and general chemistry.

Bio-accumulation

Living organisms accumulate certain pesticides. Through the process of bioaccumulation, pesticides accumulate in lower organisms and are passed to higher organisms in the food chain when eaten. The higher organism will accumulate the pesticides at higher levels than their food source. Pesticide levels in fish, for example, can be tens to hundreds of thousands of times greater than ambient water levels in which they live.

Humans are at the top of the food chain. They bio-accumulate the pesticides accumulated by the lower animals and plants that they eat. It is not only fish, but also domestic farm animals and plant food, which can accumulate pesticides. Care must be used in the use of pesticides in agricultural as well as home and garden scenarios.

THE IDEAL PESTICIDE

The 5th Edition of Truman's Scientific Guide to Pest Control Operations, 1997, described ***"The Ideal Pesticide"***. "Ideally any pesticide will act rapidly on pests, yet be completely harmless to people, domestic animals, wildlife, and other aspects of the environment. Its residues would only last as long as was necessary to create the desired effect, usually for very short periods. It would also be inexpensive and readily available in necessary quantities, chemically stable (before application), non-flammable, and otherwise safe to use around homes or industrial sites. It would be easily prepared and applied, non-corrosive and non-staining, and it would have no undesirable odor. ***Unfortunately, no such (synthetic) pesticide exists."***

Revolutionary Safe Insecticides - BIOVECTROL® and BIO-X®

Today, "Safe Insecticide" is no longer an oxymoron. When Purdue University and Advanstar Communications (Pest Control Magazine) worked on this 1997 Pest Control Manual, they were obviously still unaware that a safer alternative was already available commercially in Singapore.

Employing the latest in biotechnology, **Okada Ecotech Pte Ltd** has developed a

series of new-age environmental-friendly water-based insecticide formulations designed for public health and vector control applications. **BIOVECTROL®** (oil-in-water emulsified concentrate solution) and **BIO-X®** (a ready to use formulation available in both hand-spray and aerosol packing) very closely match the above definition of an "Ideal Pesticide".

Our formulations (**BIOVECTROL® and BIO-X®**) are based on the active ingredient, **Etofenprox®**. With a LD_{50} value of >42,880 mg/kg, it is, by far, the least toxic of all known active ingredients – technically, it can be said to be even safer than sugar and salt!

Notable product safety features are:

- Oil-in-water emulsion with inert ingredients composing entirely of natural botanical extracts and distilled water as opposed to deodorized kerosene (and other unknown inert ingredients) found in most conventional household insecticides.

- High Efficacy against a broad spectrum of vectors and insect pests.

VECTORS / PESTS	**STAGE**	**METHOD**	***LC_{50}**
Culex Pipiens	Larva	Immersion	0.0054 ppm
Culex Quinquefasciatus	Adult	WHO Test Kit	0.0036 %
Anopheles Albimanus	Adult	WHO Test Kit	0.009 %
Anopheles Gambiae	Larva	Immersion	0.009 %
Anopheles Quadrimaculatus	Larva	Immersion	0.00085 ppm
Anopheles Stephensi	Larva	Immersion	0.0073 ppm
Aedes Taeniorhynchus	Adult	Aerosol	0.0013 ppm
Musca Domestica	Adult	Topical	0.064 µg / -
Stomxys Calcitrans	Adult	Topical	0.0093 µg / -
Blattella Germanica	Adult	Topical	0.209 µg / -

**LC_{50} is the lethal concentration that causes death (resulting from a single or limited exposure) in 50 percent of the target insect pest population.*

- Kills on contact and provides excellent residual persistence on wall surfaces and net fibers;

- Safe for mammals, wildlife and aquatic animals (about 3000x safer than deltamethrin). Have no harmful influence on humans, pets, plants and nontarget organisms.

Insecticide	LD_{50} mg/kg (Rat)	Odor	Ch-Esterase Inhibition	Irritation	Effects on Aquatic Organisms
ETOFENPROX	**>40,000**	**X**	**X**	**X**	**Extremely Low Toxic**
Malathion	1,375			**X**	**Highly Toxic**
Cyfluthrin	250				**Highly Toxic**
Temephos	1,266			**X**	**Highly Toxic**
Bendiocarb	40 ~156			**X**	**Highly Toxic**
Permethrin	500	**X**	**X**	**Slight**	**Highly Toxic**
Lamda-cyhalothrin	79	**X**	**X**		**Highly Toxic**
Pirimiphos-methyl	2,018				**Highly Toxic**
Deltamethrin	129	**X**	**X**		**Highly Toxic**
Cypermethrin	250			**Slight**	**Highly Toxic**
COMPARISONS WITH COMPOUNDS FOR DAILY CONSUMPTION					
Common Salt	3,000	**X**	**X**	**X**	**NA**
Sugar	29,700	**X**	**X**	**X**	**NA**

- Vectors are unlikely to develop resistances – our active ingredient, Etofenprox is a unique C-H-O compound composed entirely of Carbon, Hydrogen and Oxygen only.

- Pleasant odor, non-flammable and non-irritant with mild deodorant and disinfectant properties makes it ideal for those who are sensitive to surface sprays.

- Non-staining formulation provides effective residual effect in the control of the mosquito vector of malaria as it can be sprayed directly onto indoor resting places favored by *Culex and Aedes* mosquitoes before and after their feeding e.g. curtains, wardrobes, furniture, etc.

- Long term and repeated applications of BIOVECTROL® will not pose any environmental pollution, by virtue of its biodegradable and photodegradable properties.

  Soil Decomposition (curtains, clothes and furniture)

Half-life of **BIOVECTROL®** is approximately 1 ~ 3 weeks in aerobic soils