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Research Paper on Low Mammalian Toxicity Insecticide and Disinfectant Using a Range of Synergistic Environmentally Friendly Chemicals

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Abstract — *This research paper relates to a range of synergistic environmentally friendly chemicals composition of a low mammalian-toxicity insecticide and disinfectant that kills flying and crawling insects through a combination induced stupors effect and desiccation of its body fluids by synergistically blending alcohol with twin-chain quaternary ammonium compound, non-ionic surfactant and essential oils.*

Keyword —Desiccation, Exoskeleton, Quaternary Ammonium Compound, Stupor Effects.

INTRODUCTION

The exoskeleton of insects acts as an impermeable, protective layer against desiccation. It is composed of an outer epicuticle, underlain by a procuticle that itself may be further divided into an exocuticle and endocuticle. [1, 2, 3] See figure 1A and 1B below.

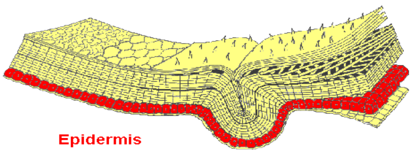

Figure 1 A

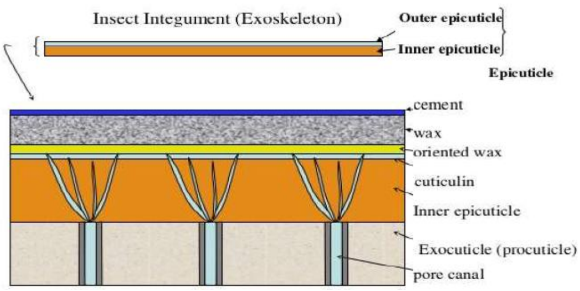

Figure 1B

THE EXOSKELETON

An insect's exoskeleton (integument) serves not only as a protective covering over the body, but also as a surface for muscle attachment, a water-tight barrier against evanescence, and a receptive contact with the surroundings. It is a multi-layered structure with four operative sectors: epicuticle, procuticle, epidermis, and basement membrane.

The epidermis is primarily a secretory tissue formed by a single layer of epithelial cells. It **is** responsible for producing at least part of the basement membrane as well as all of the overlying layers of cuticle.

The basement membrane is a supportive bilayer of amorphous mucopolysaccharides (basal lamina) and collagen fibers (reticular layer). The membrane serves as a backing for the epidermal cells and effectively separates the hemocoel (insect's main body cavity) from the integument.

The procuticle lies immediately above the epidermis, It is a long-chain of N-acetylglucosamine or chitin microfibers, it is primary component of cell walls of the exoskeletons of the arthropods.

As the procuticle forms, it is laid down in thin lamellae with chitin microfibers oriented at a slightly different angle in each subsequent layer.

The epicuticle is the outermost part of the cuticle. Its function is to reduce water loss and block the invasion of foreign matter. The innermost layer of epicuticle is often called the cuticulin layer a stratum composed of lipoproteins and chains of fatty acids embedded in a protein-polyphenol complex. An oriented monolayer of wax molecules lies just above the cuticulin layer; it serves as the chief barrier to movement of water into or out of the insect's body. In many insects a cement layer covers the wax and protects it from abrasion.

The endocuticle provides the insect with toughness and flexibility and the hard exocuticle serves to protect vulnerable body parts. [4]

Nonetheless, the external protective of coating of the epicuticle is made up of up of protein-polyphenol complex, lipoproteins, fatty acids, and waxy molecules, and is the insect's primary defence against quick excessive water loss or desiccation. [5, 6, 7]

Many insect orders secrete an additional cement coating over their defensive wax layer, to guard against the eradication of lustrous molecules.

This coating consists of lipids and proteins held together by polyphenolic compounds and secreted by the dermal glands of insects.

In general, the rate of water loss in insects is low at moderate temperatures.

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Once a species-specific critical temperature (Tc) is reached, as temperatures continue to increase, rapid water loss occurs. The rapid water loss can also occur when the epicuticle is damaged by the said chemical composition. The epicuticle of an insect is damaged when the protein-polyphenol complex made up of lipoproteins, fatty acids, and waxy molecules is emulsified.

In some insects, the rate of cuticular water loss is controlled to some extent by the neuroendocrine system, [8] for example immediately following head removal; decapitated cockroaches exhibit a large increase in transpiration across the cuticle, leading to severe dehydration. The introduction of said chemical composition of into freshly separated bodies' results in a sharp increase in cuticular water loss.

Hazardous Insecticides

For decades, distribution and use of hazardous insecticides and pesticides have been an issue of concern for both the environment and the users. Hazardous insecticides and pesticides have been shown to be linked with a high incidence of severe or irreversible adverse effects on human health or the environment. [9, 10, 11, 12].

Some examples are Organochlorine-compounds based insecticide such Endosulfan and Organ phosphorous based insecticide such as

Dichlorvous are effective insecticides but have the disadvantage of being toxic for warm-blooded animals. Toxic insecticides caused hundreds of poisonings each year throughout Asia. [13, 14,]

Organ chlorine compounds work on insects by opening the sodium ion channel in the neurons or nerve cells of insects, causing them to fire spontaneously. The insect will go into spasms and eventually die. DDT was the earliest of these chlorinated hydrocarbons, but DDT and many others in this class have been banned from general use in most countries.

Numerous studies have linked organochlorine pesticide exposures with cancers and other health effects. Exposure to DDT has been linked to pancreatic cancer and non-Hodgkin's lymphoma. Exposure to DDT early in life is associated with an increased breast cancer risk later in life. Many other organochlorine pesticides, such as mirex, chlordane and toxaphene, are known to be carcinogenic as well.

Organophosphates also work on the nervous system, keeping the nerve cells from communicating with each other. Typically, the cell of nervous system send tiny electrical pulses down the tendril both in the brains *or muscles of humans or insects send tiny electrical pulses down* tendril to the end of the cell where the pulse has to jump across a gap – known as a synapse – to another nerve cell.[15,16,17].

Acetylcholine is one of the a chemical raw materials used as neurotransmitter in both the peripheral nervous system (PNS) and central nervous system (CNS) in many organisms, including humans moves from one cell to the other and binds with the new cell, sending the electrical pulse down the new cell and it prevents Acetylcholine from coming loose from the new cell, so it can't receive any more impulses. The insects can't function and die. Malathion is a common insecticide in this class and was famous for treating infestations of the Mediterranean fruit fly and West Nile Virus-carrying mosquitoes.

Organ chlorine-The main function of organ chlorine is to cause an imbalance to sodium/potassium by acting on the neurons prohibiting the natural transmission nerve impulses, while some act on the GABA (amino butyric acid) receptor preventing chloride ions from entering the neurons causing a hyper excitable state characterized by tremors and convulsions.

Organophosphate-Causes acetyl cholinesterase (AChE) inhibition and accumulation of acetylcholine at neuromuscular junctions causing rapid twitching of voluntary muscles and eventually paralysis; broad-range insecticide, generally the most toxic of all pesticides to vertebrates the prolong consecution of severe poisoning by organophosphate includes memory and attention deficits, as well as enhanced depression, anxiety and irritability are reported following adult OP poisoning. Because the nervous system is still developing in childhood, children are believed to be at increased risk for long-term sequelae following both acute and chronic organophosphate exposure.

The above-mentioned compounds and other toxic Insecticides usually work like nerve gas agents used in warfare. In theory, they are applied at low doses so that only the insects will be directly affected. Yet, there are major concerns within the scientific and environmental communities that some of these insecticides will increase become more unmingled as they progress up the food cycle. Such example can be found in the Bald eagles, for example, the bald eagles show higher concentrations of an insecticide than the small song birds the eagles eat, and the small song birds show a higher concentration than the insects they eat who were initially treated with the insecticide.

Insecticides and pesticides are classified according to the method of application and the way they enter the insect's body. Many insecticides take effect in more than one way. [18, 19, 20].

Cytotoxic Insecticides work by being toxic to cells of the insects. Upon exposure, insects are typically knocked out. The insecticide eventually acts as poison to their bodies, eventually causing them to die.

Stomach Insecticides are applied on the surface of plants, fabrics, and wood, or are added to bait. The insecticide is eaten, along with the food material, by insects that chew, such as ants, caterpillars, and grasshoppers.

Contact Insecticides are sprayed or dusted on the insect's body. The poison is absorbed through the body wall. Most soft-bodied insects are vulnerable to contact insecticides.

Fumigants are insecticidal gases. Insects that lurk out of reach of sprays are killed when they breathe the gas. Fumigants are used by professional exterminators to rid houses of cockroaches and bedbugs and to kill beetles in grain bins. The soil may be fumigated to destroy grubs that attack roots.

Residual Insecticides are applied to foliage, the bodies of livestock and pets, and to screens and walls. Insects absorb deadly doses by touching the poisoned surface.

Systemic Insecticides are absorbed by plant tissues, so that when insects feed on the sap they are poisoned.

Receptor for Neurotransmitter insecticides work by interfering with an insect's nerve cells, preventing them from passing signals throughout the insect's body. When the cells are unable to communicate, vital body functions shut down and the insect dies.

This research article relates to a low mammalian-toxicity insecticide that uses a combination of induced stupor effect and desiccation process to kill the insects. When sprayed on the insect, the said insecticide works by inducing the insect into a state of stupor and then allowing the synergistic chemicals of the said insecticide to react on the epicuticle, by emulsifying the protecting wax molecules and the damaging the protein-polyphenol complex of the epicuticle of the insect resulting in desiccation of its body fluids

This research paper offers the chemical composition of a safe and low mammalian-toxicity insecticide and disinfectant that kills flying and crawling insects through a combination of induced stupor effect and desiccation on the insects by synergistically blending alcohol, twin-chain quaternary ammonium compound, non-ionic surfactant and essential oil. [21]

In an embodiment of this research article the ethyl alcohol (C_2H_5OH) is used primary for desiccation of the body fluids of the insects, and with its secondary functions inducing the insect into a state of stupor and works synergistically with an emulsifier and non-ionic surfactant to soften the protective wax coating from the epicuticle of the insects. [22]

In another embodiment of this research article, twin-chain quaternary ammonium compound-Didecyl Dimethyl Ammonium Chloride Molecular Formula ($C_{22}H_{48}ClN$) or Alkyl Dimethyl Benzyl Ammonium Chloride is used as an emulsifier for removing the wax coating from the epicuticle of the insect. [23, 24]

The said twin-chain quaternary ammonium compound is instrumental in emulsifying the wax components from the epicuticle of the insect, keeping them emulsified, suspended, and dispersed so they do not settle back onto the surface of the cuticle of the insect.

In yet another embodiment of this research article; non-ionic surfactant- secondary alcohol ethoxylate is used as wetting agent to help the said pesticide spread over and penetrate the waxy epicuticle of the insect or to penetrate through the small hairs present on the body of the insect, [25,26, 27]

The said non-ionic surfactants are composed of alcohols and fatty acids have no electrical charge and are compatible with most pesticides, lowering the interfacial wax tensions on the epicuticle of insects and lifting the wax off the epicuticle of the insect.

The non-ionic surfactant, twin chain quaternary ammonium compound and the ethyl alcohol are instrumental in removing wax from the epicuticle of the insect and keeping them in emulsified suspended form.

In yet another embodiment of this research article, the peppermint essential oil is used as a synergistic stupor us agent to induce the insect into a state of stupor, to allow time for the said insecticide to react with the wax coating on the epicuticle of the insect; it is also cytotoxic to the cell of insects. [28, 29, 30]

The foregoing has a broad outline of the more pertinent and important features of the present research article, in order that the detailed description that follows may be better understood so that the present article research paper contribution can be more fully appreciated.

Additional features of this research paper will be described hereinafter which form the subject of this research paper.

DETAILED DESCRIPTION OF THIS RESEARCH PAPER

In accordance with this research paper, the chemical composition consists of a synergistic blend of alcohol, either isopropyl or ethyl alcohol with twin-chain quaternary ammonium compound-Didecyl Dimethyl Ammonium Chloride Molecular Formula($C_{22}H_{48}ClN$), non-ionic surfactant- secondary alcohol ethoxlylate and essential oil-peppermint. The alcohol used is either isopropyl or ethyl in the said chemical formula composition. Due to its hygroscopic properties in nature; it desiccates the body fluids of the insects once the epicuticle and the protective wax have been damaged. It also has a secondary function of inducing the insect into a state of stupor. Either of the said alcohols in the low mammalian- toxicity insecticide of the present research paper is provided in a quantity of more than 70% by weight. [31]
The preferred alcohol used in said chemical composition is ethyl alcohol molecular formula-C_2H_6OH due to its lower toxicity than isopropyl. [32]

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The twin-chain quaternary ammonium compound used is either Alkyl Dimethyl Benzyl Ammonium Chloride or Didecyl Dimethyl Ammonium Chloride. The preferred twin-chain quaternary ammonium compound is Didecyl Dimethyl Ammonium Chloride molecular formula-$C_{22}H_{48}CIN$; is used in said chemical composition because of its excellent emulsification properties when blended synergistically with other said chemicals. The said twin-chain quaternary ammonium compound in the chemical composition of the low mammalian-toxicity insecticide is provided in a quantity of more than 0.5% by weight.

The said twin-chain quaternary ammonium compound is instrumental in emulsifying the protective wax components from the epicuticle of the insect and in keeping them emulsified, suspended, and dispersed so they do not settle back onto the surface of the epicuticle of the insect.

The preferred non-ionic surfactant is secondary alcohol ethoxylate of 7 moles and with a HLB 12.1 (Hydrophilic-lipophilic Balance) because of its superior wetting properties; low toxicity and biodegradability properties over Nonyl Phenol non-ionic surfactants.

The function of the said surfactant in the chemical composition is used as a wetting agent to help the said insecticide mixture spread over and penetrate the epicuticle of the insect or to penetrate through the small hairs present on the body of the insect, it lowers the interfacial wax molecules tensions on the epicuticle of insects and in this way lifts the protective wax off the epicuticle of the insect. [32, 33, 34, 35]

The said surfactant in the chemical composition of the low mammalian-toxicity insecticide is provided in a quantity of more than 0.5% by weight.

The non-ionic surfactant, emulsifier and the ethyl alcohol are instrumental in removing the protective wax, from the epicuticle of the insect and keeping them in emulsified suspended form.

The preferred peppermint essential oil in the said chemical composition is Mentha piperita (molecular formula $C_{62}H_{108}O_7$); because of its good stupor us effects on insects when blended with the said chemicals. It induces the insect into a state of stupor, while allowing the said insecticide to react with the wax coating on the cuticle of the insect.

The said peppermint essential oil in the chemical composition of the low mammalian toxicity insecticide is provided in a quantity of more than 1% by weight.

EXAMPLES

By way of example and not limitation, the following are illustrative of various embodiments of the foregoing research paper.

Example 1 This example illustrates the typical chemical composition of a low mammalian-toxicity insecticide that kills insects through stupor us affect and desiccation of its body fluids.

A typical said chemical composition consists of 90 wt % of ethyl alcohol, 2 wt % of Didecyl Dimethyl Ammonium Chloride, 2% by weight secondary alcohol ethoxylated 7 moles with HLB of 12.1, and 6 wt % of peppermint oil-mentha piperita to complete the said chemical composition.

Example 2 This example illustrates another typical chemical composition of a low mammalian-toxicity insecticide that kills insects through stupor us affect and desiccation of its body fluids. The said chemical composition consists of 93 wt % of ethyl alcohol, 1 wt % of Didecyl Dimethyl Ammonium Chloride, 1 wt % of secondary alcohol ethoxylated 7 moles with HLB of 12.1, and 5 wt % of peppermint oil-mentha piperita to complete the said chemical composition.

This example illustrates another typical chemical composition of a low mammalian-toxicity insecticide that kills insects through stupor us affect and desiccation of its body fluids.

The said chemical composition consists of 95 wt % of ethyl alcohol 1 wt % of Didecyl Dimethyl Ammonium Chloride, 1% by weight secondary alcohol ethoxylated 7 moles with HLB of 12.1, and 3 wt % of peppermint oil-mentha piperita to complete the said chemical composition.

CONCLUSION

The foregoing embodiments are susceptible to considerable variation in its practice. Accordingly, the embodiments in this research paper are not intended to be limited to the specific exemplifications set forth hereinabove.

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[32]. Ethanol vs. Isopropyl Alcohol to Disinfect | Hunker https://www.hunker.com › Home Hacks & Answers › Housekeeping › House Cleaning May 22, 2010 - Isopropyl alcohol, often called IPA or isopropanol, is similar in function and structure toethanol. It evaporates at a similar rate and destroys bacterial and viral cells by the same mechanism. However, it is not as effective at dehydrating living tissue and so is a better solution for disinfecting skinthan ethanol.

[33]. Permeability of the Insect Cuticle To ... - Open Collections https://open.library. ubc.ca /media/download/pdf/831/1.0104857/2 To remove the wax layer, insects were, submerged in a 2% solution of Triton X-100, a water soluble non-ionic surface active agent of the composition iso-octyl phenoxy polyethoxy ethanol, manufactured by the Rohm and Haas Company, Philadelphia. Adult C. exp1eta were collected from their natural habitat in Long Lake,.

[34]. on the penetration of insecticides through the insect cuticle https:// pdfs. semanticscholar. org/3efd/37caf62eb0176bc39715092695d700c695c7.pdf by JE WEBB - Cited by 34 - Related articles efficiency. Wigglesworth (1944) has shown that when the waxes covering the surface of the cuticle are removed by abrasion with hard dusts, evaporation of water from the underlying layers of the cuticle readily takes place and death of the insect from desiccation ensues. It is clear, therefore, that the wax must be in contact.

[35]. Transpiration through the cuticle of insects - Journal of, jeb.biologists.org/content/jexbio/21/3-4/97.full.pdf by VB WIGGLESWORTH - 1945 - Cited by 374- Related articles Dust in stationary contact with the cuticle will not adsorb lipoid material and so break the film. But the cuticular wax of Rhodnius is a hard material with a high melting-point (Beament,. 1945) and a high critical temperature. It is possible that adsorption alone may serve to remove the water- proofing layer in insects with waxes.

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