INTERNATIONAL ASSOCIATION OF BIOLOGICALS AND COMPUTATIONAL DIGEST
International & Peer-Reviewed Journal
E-ISSN: 2583-3995

A REVIEW ON PYRETHROID AS INSECTIDE AND IT'S ADVERSE EFFECT ON HUMAN

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ABSTRACT

Synthetic pyrethroids are insecticide as well as pesticide made from naturally occurring pyrethrins found in dried Chrysanthemum flowers' pyrethrum. In present review use of pyrethroid as insecticide and its harmful effects on human beings are focused. Pyrethroids Modifying the kinetics of voltage-sensitive sodium channels, which mediate the nerve membrane's temporary increase in sodium permeability that underpins the nerve action potential, has an effect on insect nerves, with is benefits it also shows adverse effect on human health if its consumption is high it can cause damage to sperm DNA, respiratory disorder, circulatory disease and many more.

Keywords: *Pyrethroid, Pyrthrin, Synthetic pyrethroid, Disease, neurotoxic.*

INTRODUCTION

Pyrethrum is a plant that belongs to the Asteraceae family that produces the insecticide pyrethrin when the aromatic flower heads are powdered (Xu., 2019). The United States Environmental Protection Agency registered permethrin for the first time in 1979. Pyrethrin is a pyrethrum extract that has been refined (Soni., 2014). The plants were historically known as a separate genus, Pyrethrum, and the taxonomy between Tanacetum and Chrysanthemum is still debated. *Tanacetum coccineum,* also known as painted lady, is a florist's favorite perennial pyrethrum. Wide deep rose-colored ray flowers surround the yellow middle, or disk, on long simple stems above the crown of finely cut leaves. White ray flowers surround a yellow base on the daisy-like pyrethrum daisy scientifically known as Chrysanthemum cinerariifolium. The leaves are blue-gray and are profoundly divided. The plant is indigenous to the Balkans and is used to make pyrethrin. Most other Chrysanthemum species have pyrethrin compounds and are generally used as "companion plants" to keep insects away from ornamental and edible plants. Pyrethroid insecticides have been used in agricultural and household formulations for over 30 years and account for around a quarter of the global insecticide market (Shafer *et al.*, 2005). Pyrethroids are composed of two, four, or eight isomers due to their complex chemical structure, and commercially available products which contain a mixture of these isomers (Thatheyus and Selvam., 2013)

CHEMICAL STRUCTURE OF PYRETHRIN

Pyrethrin I and II, cinerin I and II, and jasmolin I and II are the six constituents of pyrethrins. Pyrethrins are the esters of two carboxylic acids, chrysanthemic which pyrethrin acid, and are collectively known as pyrethrins.

Pyrethrin I and II, are esters of 2,2-dimethyl-3-(2-methyl-l-propenyl)_I_cyclo_ propanecarboxylic acid (chrysanthemic) and of 3-(2-methoxycarbonyl-l-prope_ nyl)-2,2-dimethyl-l-cyclopropanecarboxylic acid (pyrethric acid), respectively.

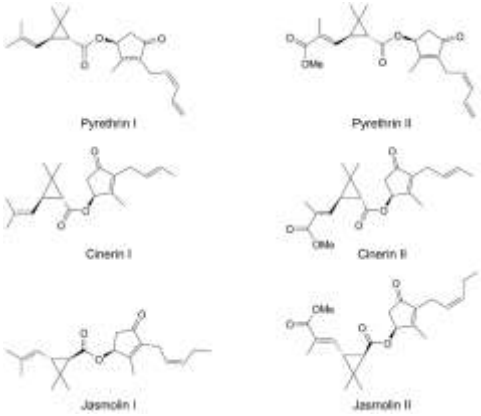

Fig 1: Chemical structures of naturalpyrethrins I and II, cinerins I and II, and jasmolins I and I

PHYSICAL PROPERTIES OF PYRETHRIN

Pyrethrum appears as a tan-colored dust in the form of ground flowers or as a syrupy liquid in the form of crude extract. Pyrethrins are soluble in organic solvents such as alcohol, chlorinated hydrocarbons, and kerosene, but only mildly in water. Pyrethrins are commonly found in household insecticides and products designed to keep insects away from pets and livestock. Pyrethrins degrade rapidly in the environment, especially when exposed to sunlight. (Todd *et al.,* 2003)

Pyrethroids

Pyrethroids appear to have a much higher magnitude of age-related toxicity than many other pesticide classes, but the number of studies is small. The discovery and development of synthetic pyrethroid insecticides has been the subject of numerous reviews Pyrethroids are synthetic chemicals with a structure similar to pyrethrins, but they are more poisonous to insects and mammals and have a longer shelf life in the atmosphere. Only a few dozen synthetic pyrethroids are currently in use in the United States, even though over 1,000 have been manufactured. Synthetic pyrethroids have a wide range of structures and applications in agricultural, veterinary, medical, and household pest control, thanks to decades of research and development by the agrochemical industry, government, and academic research laboratories. (Soderlund *et al.,*2002)

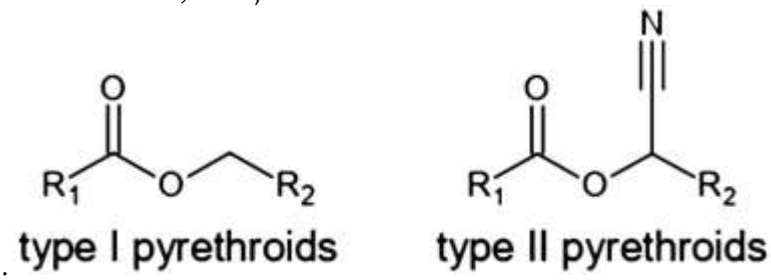

Fig 2: Two types of pyrethroids

Development of synthetic pyrethroids

Numerous studies have been performed on the discovery and production of synthetic pyrethroid insecticides. The main disadvantage of pyrethrum as an insecticide is that it is unstable in light and air, limiting its use in crop protection and other insect control situations where residual activity is needed. Artificial modifications usually left one of the molecule's major domains unchanged while adding new structural features to the other. Pyrethrins and pyrethroids are often mixed commercially with other chemicals known as synergists, which improve the insecticidal activity of the pyrethrins and enhance their toxicity by preventing certain enzymes from breaking down pyrethrins and pyrethroids. Allethrin synthesis was the first active modification, which involved removing one vinyl group from the unstable diene structure. Allethrin had a similar takedown action to pyrethrin I. (Ujihara., 2019)

The value of overall molecular form in pyrethroid action is best illustrated by the insecticidal action's absolute stereospecificity. Two pairs of 8 D.M. are generated by the presence of two chiral centers at carbon 1 and carbon-3 of the chrysanthemic acid substituents of pyrethrin

I. Diastereomers are classified as trans or cis depending on the orientation of the C-1 and C-3 substituents in relation to the cyclopropane ring plane (Todd *et al.*, 2003). Natural pyrethrin acid substituents are exclusively in the 1R, trans configuration. The esters of the four resolved chrysanthemic acid isomers with the R configuration at cyclopropane C-1 were insecticidal, while the enantiomeric 1S compounds, considering their physical similarity, were not. (Soderlund *et al.,* 2002)

Mode of action of pyrethroid as insecticide

Pyrethroids are said to alter the normal function of insect nerves by salialtering the kinetics of voltage-sensitive sodium channels, which mediate the nerve action potential's temporary increase in sodium permeability. (Soderlund *et al.*, 2002)

Pyrethrins and pyrethroids can penetrate the body of an organism in a number of ways to exert their effects. The non-stereospecific first mode includes rapid penetration through the epidermis, absorption by blood or hemolymph carrier proteins, and distribution across the body. Pyrethroid diffusion along epidermal cells is the main route of transmission to the central nervous system after penetration (CNS). Pyrethroids can also enter the CNS directly via the sensory organs of the peripheral nervous system (Shafer., 2005). Pyrethroids affect both invertebrates and vertebrates' sensory systems. Pyrethroids can also enter the body through the airway in the vapor phase, although this penetration is minimal due to the low vapor pressure of pyrethroids. Pyrethroids can also be absorbed, and their absorption into the blood-hemolymph system through the alimentary canal can greatly increase toxicity.

There are two type of pyrethrin were found,The T-syndrome is a phenotype of type I pyrethroids that includes vigorous sparring, sensitivity to external stimuli, fine tremors that progress to whole-body tremors, and prostration. The intense muscle activity associated with tremors causes Type I pyrethroids to raise core body temperature as well. In type II pyrethroids, the CS syndrome is defined by pawing and burrowing activity, as well as profuse salivation, choreoathetosis, increased startle response, and terminal chronic seizures. Excessive salivation and wetting of the ventral body surface are related to Type II pyrethroids lowering core body temperature. While choreoathetosis is usually associated with salivation, a TS syndrome (tremor with salivation) has been reported in a few pyrethroids (Chrustek *et al,*. 2018). Multiple lines of evidence suggest that pyrethroids as a class do not behave in the same way on voltage-gated sodium channels, and toxicological classifications for invertebrates and vertebrates are not absolute. Bioallethrin, a type I pyrethroid, for example, has toxicological effects of both type I and type II intoxication.

As pyrethroids are used as insecticide, some of research revel their use as pesticide as well as repellent to the malaria vector mosquitoes. Clothing treated with pyrethroids is usually worn to keep mosquitoes at bay; pyrethroids are both insecticides and repellents. (Bowman *et al.*, 2018)

Adverse effect on human and environment

Permethrin has a powerful anti-insect effect, but it is less harmful to humans and domestic animals because their sodium channels are less sensitive. Insecticides are commonly used on domestic animals, which can be detrimental to their welfare (Chrustek *et al.,* 2018). Research done by (Jurewicz *et al.,* 2015) studied on men under 45 years and revels that pyrethroids are responsible for the damange of sperm DNA.

Research done as Detailed toxicology and metabolism studies aimed at determining human risk had shown that pyrethroids cause pronounced repetitive behavior marked by tremor, hypersensitivity, choleoathetosis, and salivation when the voltage-dependent sodium channel is the target site. In addition, cyano-pyrethroids cause workers to experience intermittent skin paresthesia. (Miyamoto *et al.,*1995).

In mammals, tissue accumulation has not been recorded. Pyethrum may harm the central nervous system and the immune system in high doses. Animals fed large doses of pyrethrins can develop liver damage. (Schoenig *et al.*,1995). Pyrethrins affect blood sugar levels as well as its capacity to hold oxygen. An injection of pyrethrins caused gerbil blood sugar levels to increase by 30 to 70 percent, according to researchers from the University of Rajasthan in India (depending on dose). Blood sugar peaked an hour after treatment, but the increase persisted for several days (Saxena *et al.*, 1978) humans can absorb pyrethrum more quickly through the lungs during respiration. The pyrethrum compound used appears to affect the response. Inhaling large quantities of pyrethrum can cause asthmatic symptoms such as

sneezing, nasal stuffiness, headaches, nausea, tremors, convulsions, facial flushing and swelling, as well as burning and itching. (Kakko *et al.*, 2000)

Pyrethrins are only present for a brief period outside. For example, the half-life (the time it takes for half of the applied pyrethrin to break down or travel away from the application site) of pyrethrins applied to bare soil was two hours or less. Pyrethrins are much more stable indoors than they are outdoors. Pyrethrins were found to survive 60 hours after treatment on horizontal surfaces, two weeks after treatment on airborne particles, and over two months in carpet dust, according to research conducted at the University of Ulm and the Fraunhofer Institute of Toxicology and Aerosol Research in Germany (soni, 2014).

CONCLUSION

Natural pyrethroids are modified in different forms of synthetic pyrethroids on basis of their use in field or homes as insecticide, pesticide or mosquito repellent and also to reduce its toxic effect on human and domestic animals. Usage of pesticides regulated by global organizations such as the World Health Organization (WHO) and the European Union (EU), as well as national legislation in many countries, due to the harmful effects of pesticides on human and animal species as well as the environment. The WHO allows only three natural pesticide derivatives of the pyrethroid group to be used: deltamethrin, permethrin, and alpha-cypermethrin. Present study indicates that these products are far from safe for human health, and that any insecticide should be used with extreme caution. (Chrustek., 2018)

REFERENCES

1) Sharma, H. N., Saxena, P. N., Upadhyay, V. K., Rana, N., & Saxena, N. Cuticular Biochemistry: Lambda-Cyhalothrin Induced Alterations in Mutant Drosophila melanogaster. Journal of Advanced Laboratory Research in Biology, 7(3), 76-78.
2) Elliott, M., & Janes, N. F. (1978). Synthetic pyrethroids–a new class of insecticide. Chemical Society Reviews, 7(4), 473-505
3) Miyamoto, J. (1981). The chemistry, metabolism and residue analysis of synthetic pyrethroids. Pure and Applied Chemistry, 53(10), 1967-2022.
4) Brown GB, Gaupp JE, Olsen RW. 1988. Pyrethroid insecticides: Stereospecific allosteric interaction with the batrachotoxinin—A benzoate binding site of mammalian voltage-sensitive sodium channels. Mol Pharmacol 34:54-59.
5) Schoenig, G. P. (1995). Mammalian toxicology of pyrethrum extract. Pyrethrum Flowers: Production, Chemistry, Toxicology and Uses. Oxford, New York, USA, 249-257.
6) Kakko, I., Toimela, T., &Tähti, H. (2000). Piperonyl butoxide potentiates the synaptosome ATPase inhibiting effect of pyrethrin. Chemosphere, 40(3), 301-305.
7) World Health Organization and Food and Agriculture Organization of the United Nations. 2000. Pesticide residues in food—2000. FAO Plant Production and Protection Paper 163. p. 114
8) Soderlund, D. M., Clark, J. M., Sheets, L. P., Mullin, L. S., Piccirillo, V. J., Sargent, D., ... & Weiner, M. L. (2002). Mechanisms of pyrethroid neurotoxicity: implications for cumulative risk assessment. Toxicology, 171(1), 3-59.
9) Laskowski, D. A. (2002). Physical and chemical properties of pyrethroids. Reviews of environmental contamination and toxicology, 49-170.
10) Todd, G. D., Wohlers, D., & Citra, M. J. (2003). Toxicological profile for pyrethrins and pyrethroids. Agency for toxic substances and disease registry
11) Shafer, T. J., Meyer, D. A., & Crofton, K. M. (2005). Developmental neurotoxicity of pyrethroid insecticides: critical review and future research needs. Environmental health perspectives, 113(2), 123-136.
12) Schleier III, J. J., & Peterson, R. K. (2011). Pyrethrins and pyrethroid insecticides (Vol. 11, pp. 94-131). London: Royal Society of Chemistry.
13) Thatheyus, A. J., & Selvam, A. D. G. (2013). Synthetic pyrethroids: toxicity and biodegradation. Appl Ecol Environ Sci, 1(3), 33-36.
14) Duchon, S., Bonnet, J., Marcombe, S., Zaim, M., & Corbel, V. (2014). Pyrethrum: a mixture of natural pyrethrins has potential for malaria vector control. Journal of medical entomology, 46(3), 516-522.
15) Jurewicz, J., Radwan, M., Wielgomas, B., Sobala, W., Piskunowicz, M., Radwan, P., ... & Hanke, W. (2015). The effect of environmental exposure to pyrethroids and DNA damage in human sperm. Systems biology in reproductive medicine, 61(1), 37-43.

16) Use of Pyrethrin/ Pyrethrum and its Effect on Environment and Human: A Review
17) Bowman, N. M., Akialis, K., Cave, G., Barrera, R., Apperson, C. S., &Meshnick, S. R. (2018). Pyrethroid insecticides maintain repellent effect on knock-down resistant populations of Aedes aegypti mosquitoes. PLoS One, 13(5), e0196410.
18) .Chrustek, A., Hołyńska-Iwan, I., Dziembowska, I., Bogusiewicz, J., Wróblewski, M., Cwynar, A., &Olszewska-Słonina, D. (2018). Current research on the safety of pyrethroids used as insecticides. Medicina, 54(4), 61.
19) Ujihara, K. (2019). The history of extensive structural modifications of pyrethroids. Journal of pesticide science, D19-102.
20) Xu, H., Li, W., Schilmiller, A. L., van Eekelen, H., de Vos, R. C., Jongsma, M. A., &Pichersky, E. (2019). Pyrethric acid of natural pyrethrin insecticide: complete pathway elucidation and reconstitution in Nicotiana benthamiana. New Phytologist, 223(2), 751-765.