Study on Cypermethrin Binding Domain of Voltage Gated Sodium Channel in Some Insect and Human beings

Samanta Aveek
Department of Botany, Prabhat Kumar College, Contai, West Bengal, 721404, INDIA
aveekbot@gmail.com

Abstract
Insecticide chalks are mostly made up of a chemical named Cypermethrin, which is one type of class-II pyrethroid pesticide. The study shows that the chemical binds to the voltage gated sodium channel especially on the side of Sodium inactivation gate with 'F' or phenylalanine residues. The F residues are conserved among selected sequences. This study shows that the chemical can binds to the voltage-gated sodium channel of some common insects as well as with human voltage-Gated Sodium Channel.

Keywords: Cypermethrin, Insecticide, Sequence alignment, Sodium channel, Voltage-gated.

Introduction

Cypermethrin (Molecular Formula: $C_{22}H_{19}Cl_2NO_3$, Boiling point: 220°C, Molar mass: 1260.9/mol) is one type of class-II pyrethroid pesticide used in several types of insecticides and in other poisonous things. The IUPAC name of this chemical is [cyano(3-phenoxyphenyl) methyl]3-(2,2dichloroethenyl) 2,2- dimethyl cyclopropane-l-carboxylate[10,13]. It was first synthesized in 1974[12]. Cypermethrin is a synthetic chemical similar to the pyrethrins in pyrethrum extract. It kills insects that eat or come into contact with it and works quickly affecting the insect's central nervous system[1].

The typical half-life of cypermethrin in the soil is 30 days to eight weeks and on foliage is 5 days[4,9]. Cypermethrin is a stable compound in sunlight. When the brain cells of cockroach are exposed to very small doses (up to 0.02 micrograms per gram of brain weight or cg/g) of cypermethrin, they exhibit a nervous system response, which would result in restlessness, incoordination, prostration and paralysis of the insect[5,6].

This chemical is easily available in the chalk in different household and agricultural purpose as insecticide, especially in developing countries[7,11]. Cypermethrin interacts with the sodium channel in nerve cells and interferes with the nerve signal[1,3]. In this work, it is aimed to assess the molecular similarity of the site where the chemical binds among insects and human beings.

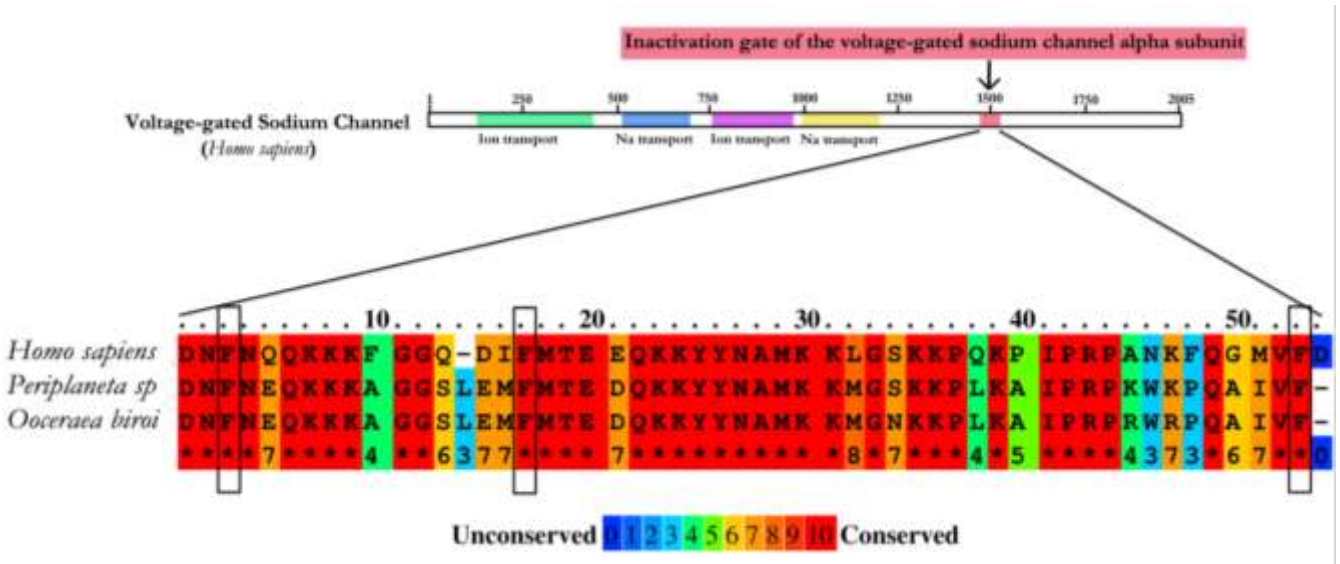

Figure 1: *In silico* relationship among insect and Human being. The conservation of phenylalanine residues are shown in box

Material and Methods

A search is performed from database NCBI (http://www.ncbi.nlm.nih.gov/) for retrieving data on Voltage-Gated Sodium Channel. A careful alignment is then carried out with the derived sequences from the database. Sequences that shared 95% or higher identity are considered as likely alleles[8]. Cypermethrin binding domains using keywords namely, 'Human Voltage-Gated sodium Channel' and 'Insect Voltage-Gated sodium Channel' are retrieved from NCBI database. From the retrieved voltage gated

sodium channel sequences, the portion of 'Inactivation gate' are taken out.

Moreover, the 'inactivation gate' domain sequences are used for Multiple Sequence Alignment (MSA) using BLAST against NCBI. Conservation scoring is performed by PRALINE (http://www.ibi.vu.nl/programs/pralinewww/)[2].

***In Silico* Study of Voltage-Gated Sodium Channel (VGSE) among Insects and Human beings:** The study shows that the chemical cypermethrin can bind with the voltage gated sodium channel, especially on the site of Sodium (Na+) inactivation gate with 'F' or phenylalanine residues. The common insects, cockroach and ant have this 'F' or phenylalanine site. Human beings also have the same site with similar amino acid sequences (fig 1). The F sites are conserved among the studied sequences.

Conclusion

The *in silico* study reveals that there is sequence similarity of voltage-gated sodium channel (VGSE) especially among Inactivation gate of the voltage-gated sodium channel alpha subunit (The binding site of the drug cypermethrin). This site is present among insects and human beings. The cypermethine binding F residues are present in all cases. The conservation pattern is also high for the VGSE sequences. From the study, it can be said that the chemical can also bind with the human VGSC to cause several neurological problems as in insects.

Acknowledgement

Author is thankful to Dr. Goutam Dutta, Head of the Department of Physiology, Prabhat Kumar College, Contai, for providing necessary suggestion preparing the manuscript.

References

1. Abbassy M.A., Eldefrawi M.E. and Eldefrawi A.T., Pyrethroid action on the nicotinic acetylcholine receptor / channel, *Pesticide Biochem Physio*, **19**, 299 **(1983)**

2. Canzar S.1., El-Kebir M., Pool R., Elbassioni K., Mark A.E., Geerke D.P., Stougie L. and Klau G.W., Charge group partitioning in biomolecular simulation, *J Comput Biol*, **20(3)**,188-98 **(2013)**

3. Chakravarti K. and Naravaneni R., Philip GH Study of Cypermethrin Cytogenesis effects on Human Lymphocytes Using *In-Vitro* Techniques, *J. Appl. Sci. Environ. Manage*, **2**, 77 – 81 **(2007)**

4. Clark J.M. and Brooks M.W., Neurotoxicology of pyrethroids: single or multiple mechanisms of action?, *Environ Toxicol Chem*, **8**, 361 **(1989)**

5. Das R.N. and Parajuli S., Cypermethrin Poisoning and Anti-cholinergic Medication- A Case Report, *Internet Journal of Medical Update*, **2**, 42-44 **(2006)**

6. Gammon D.W. et al, Two classes of pyrethroid action in the cockroach, *Pestic. Biochem. Physiol*, **15**, 181-191 **(1982)**

7. Knisel W.G., ed., Groundwater Loading Effects of Agricultural Management Systems, Version 2.10, [Online] **(1993)**

8. Kumar S., Tamura K. and Jakobsen I.B., Nei M MEGA2: molecular evolutionary genetics analysis software, *Bioinformatics*, **17**, 1244–1245 **(2001)**

9. Lawrence J.L. and Casida J.E., Pyrethroid toxicology: mouse intracerebral structure-toxicityrelationships, *Pestic. Biochem. Physiol*., **18**, 914 **(1981)**

10. Peter V.J., John G. and Cherrian A.M., Pyrethroid poisoning, *J Assoc Physicians India*, **44(5)**, 343-4 **(2007)**

11. Tomlin C., ed., A World Compendium, The Pesticide Manual, Incorporating the agrochemicals handbook, 10th ed., Bungay, Suffolk, U.K., Crop Protection Publications **(1994)**

12. United States Environmental Protection Agency, Cypermethrin Pesticide Fact Sheet, Washington, D.C. **(1989)**

13. World Health Organization, Environmental Health Criteria, Cypermethrin, Geneva, United Nations Environmental Programme, the International Labour Organization and the World Health Organization **(1989)**.

(Received 06th June 2018, accepted 01st July 2018)

*****