Optical control of insect behavior via ionotropic GABA receptors

CHUN QING ZHAO[1], Qiu Tang Huang[1], Xu Sheng Shao[2], Qing Qing Hou[2], Qi Xu[2], Cong Zhou[2], Yao Yao Du[2], Yun Fan Ji[2], Zhi Ping Xu[2], Jia Gao Cheng[2], and Zhong Li[2]

[1]Nanjing Agricultural University
[2]East China University of Science and Technology

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Abstract

BACKGROUND AND PURPOSE Ionotropic GABA receptors (GABARs) in insects are the major inhibitory receptor and common targets in insecticides for pest control. Due to their high spatiotemporal resolution, the photopharmacological ligands have been developed in vertebrates, but only a few in insect yet. EXPERIMENTAL APPOACH In this study, two types of photoswitchable ligands (PCLs) by incorporating photoswitch azobenzene or dithienylethene into the antagonist, fipronil (FIP) generated the DTFIPs (DTFIP1 and DTFIP2) and ABFIPs (p-, m-, and o-ABFIP). Their photomodulation was measured by mosquito larval behavior, and the potential action mechanism of them was explored by two-electrode voltage clamp (TEVC) technique in vitro. KEY RESULTS DTFIP1 and m-ABFIP exhibited biggest difference of insecticidal activity between unirradiated and irradiated formation, and allowed for optical control of insect locomotors activity in swimming. The TEVC assay results indicted m-ABFIP and DTFIP1 enable optical control over the homomeric RDL-type GABAR, which is achieved by regulating the chloride channel of insect resistance to RDL-type GABAR by photoisomerization. CONSLUSION AND IMPLICATIONS Our results suggested that PCLs provide an alternative and precise tool for studying insect ionotropic GABARs and GABA-dependent behavior.

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