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基于模式生物秀丽隐杆线虫的三丁基锡生态毒性评价

Assessment of tributyltin ecotoxicity using a model animal nematode *Caenorhabditis elegans*

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中文摘要:

利用秀丽隐杆线虫半致死浓度分析和致死曲线分析来筛选对三丁基锡(Tributyltin,TBT)敏感的线虫品系,并讨论与TBT毒理学过程可能相关的基因。通过对秀丽隐杆线虫体长、每窝子代数和怀卵量的测定来探讨TBT的生态毒性效应,以期为TBT对秀丽隐杆线虫和人类的生态毒性评价和致毒机理研究提供科学依据。结果表明:TBT对各品系线虫48 h LC_{50}从小到大依次为*egl-1*(*n487*)＜*ced-4*(*n1162*)＜*cep-1*(*gk138*)=*cep-1*(*lg12501*)＜*ced-9*(*n1950*)＜*clk-2*(*mn159*)＜*ced-3*(*n717*)＜N2＜opIs34(*hus-1*::GFP) ＜opIs56(*egl-1*::GFP)＜*daf-16*(*mn86*)＜*hus-1*(*op241*)＜*daf-2*(*e1370*)。筛选出对TBT最敏感的线虫品系为*egl-1*(*n487*),而对TBT耐受力最强的是*daf-2*(*e1370*)。TBT对秀丽隐杆线虫体长、每窝子代数和怀卵量均呈现浓度依赖型的抑制作用。

English Summary:

Tributyltin(TBT)has been widely used as antifouling paint for vessels and,as a result,has been released into aquatic environment since the 1960s. Although the use of TBT paints has been banned recently,significant quantities of TBT and its metabolites are still detectable in many regions. They can exist for long periods in aquatic organisms and sediments. It is widely acknowledged that triorganotins,especially TBT compounds,are among the most toxic substances ever introduced deliberately into the marine environment. The toxic effects of TBT have been documented in several experimental systems,however, due to its adverse impacts on the ecosystems,the development of sensitive bioassay systems with multi-endpoints are essential for risk assessment and mechanism study.
Toxicity bioassay techniques,as a powerful approach for environmental assessment and toxicity testing,has become a fundamental tool to evaluate the early warnings of potential environmental pollutants that are hazardous to the health of humans and wild animals. However,the organism should meet several criteria before it is selected as a bioindicator. It should have endpoints sensitive to the tested pollutants,can operate rapidly and easily,can allow the testing of a large number of samples in a small volume, and is inexpensive. The free living nematode *Caenorhabditis elegans* has been proved to be a good model for the evaluation of toxicological effects of environmental chemicals or toxins,the results are comparable to that of mammalians. In the present study,the nematode *C. elegans* was employed to investigate the toxicity of TBT. To determine the acute toxic effects of TBT to *C. elegans*,a range of worm strains were exposed to graded doses of TBT for 48 h. The median lethal concentrations(LC_{50})were estimated in these strains with different genes knocked out. To screen the sensitive sublethal endpoints for the risk assessment of TBT to the environment, the body size,fecundity and brood size were assayed in the wild type N2. The results presented here implicated that the nematode *C. elegans* could be used as substitutive model in evaluation the toxic effects of TBT in the environment. The 48 h LC_{50} observed on the wild type and mutant strains for TBT were in the order of *egl-1*(*n487*)＜*ced-4*(*n1162*)＜*cep-1*(*gk138*)=*cep-1*(*lg12501*)＜*ced-9*(*n1950*)＜*clk-2*(*mn159*)＜*ced-3*(*n717*)＜N2＜opIs34(*hus-1*::GFP) ＜opIs56(*egl-1*::GFP)＜*daf-16*(*mn86*)＜*hus-1*(*op241*)＜*daf-2*(*e1370*). The results of LC_{50} suggested that the strains carrying the mutant genes *daf-2, hus-1* and *daf-16* are less sensitive than that of N2,respectively. Conversely,*egl-1*,*ced-4*,*cep-1*,*ced-9* and *clk-2* loss-of-function strains exhibited more sensitive to TBT exposure than that of N2,implying that these genes may contribute to the protection effects from TBT toxicity in *C. elegans*. Therefore,*egl-1*(*n487*)is one of the most sensitive strains to TBT stress,while long-lived *daf-2*(*e1370*)is one of the most tolerant strains to TBT stress. In our study,the body length of *C. elegans* was inhibited as low as 10 nmol/L TBT. The fecundity decreased significantly at the dose exceeding 50 nmol/L,similar effects were observed for brood size. Our present results indicated that LC_{50} of the mutated strain *egl-1*(*n487*),the body length,brood size and fecundity of *C. elegans* are the sensitive endpoints to indicate TBT contamination in aquatic environments.

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