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APPLICATIONS AND ADVANCES IN BIOASSAY METHODS FOR ECOTOXICOLOGICAL ASSESSMENT OF XENOBIOTICS

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Abstract

Bioassays (commonly used shorthand for biological assay or assessment) are analytical methods to determine biological hazards of xenobiotics on living animals or plants (in vivo bioassays), or on living cells or tissues (in vitro bioassays). Chemical substances that are not naturally found in the environment and are often introduced as a result of anthropogenic factors are called as xenobiotics. Bioassays determine biological responses against these chemicals that provide essential data for environmental monitoring and risk assessment. This review emphasizes the applications, advantages, challenges, significances and critical roles of bioassays in ecotoxicology, and the advances in its methods. Particularly, it was focused on the significance, advantages and applications of in vivo bioassays in environmental risk assessment by means of exemplifying with various case studies used different taxa of vertebrates as model organisms. These bioassays assessing the effects of xenobiotics on living organisms within their natural or semi-natural environments are crucial tool in ecotoxicology because of their ecological relevance, ability to detect sub-lethal effects and capacity to conduct holistic assessments. Advances in bioassay methodologies have been enhancing the accuracy and efficiency of ecotoxicological assessments contributing to the protection of environmental health and biodiversity against increasing environmental challenges.

Keywords: *bioassay; ecotoxicology; environmental monitoring; risk assessment; xenobiotics*

1. Introduction

Biological assessments, also called bioassays which determine biological responses against xenobiotics are crucial tool in ecotoxicology because of their ecological relevance, ability to detect sub-lethal effects and capacity to conduct holistic assessments. Chemical substances that are not naturally found in the environment and are often introduced as a result of anthropogenic factors are called as xenobiotics. Ecotoxicological bioassays provide essential data for environmental monitoring and risk assessment. This review emphasizes the significance and roles of acute and chronic toxicity testing methods and models with vertebrates in ecotoxicology.

Vertebrate models

It particularly focused on "in vivo bioassays" exemplifying with various case studies used amphibian and mammalian models in environmental risk assessment. Biochemical, hematological and histopathological effects of pesticides were demonstrated by using mammalian toxicity test models [1, 2, 6]

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(Fig. 1-2). As amphibian embryos can be used in toxicity studies as indicators of environmental quality for wildlife protection purposes, we also use native amphibian species of Türkiye as model organisms in ecotoxicological risk assessments of wetland ecosystems. Mortality, malformation, and inhibition of development and growth were considered as end points to evaluate the toxicity in these models [3, 4, 5, 7] (Fig. 3-4). As a reliable and realistic amphibian model, employing ecological relevant species of Türkiye for evaluating the potential risks of xenobiotics does not exist, an ecotoxicological test model with native species of Türkiye, *Bombina bombina*, was described and named as "BOMBITOX" [3, 7, 9]. It was found to be useful in testing developmental toxicity of pollutants and to meet both ecologic and economic criteria.

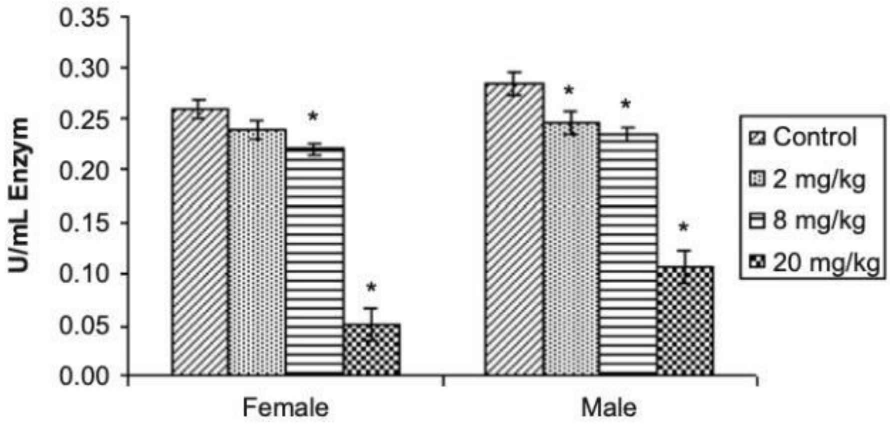
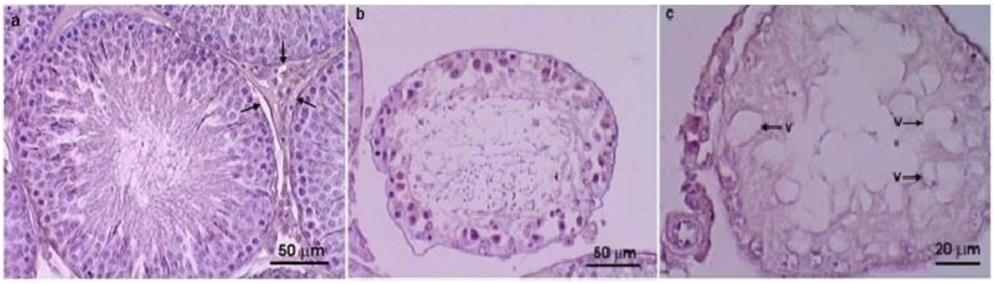


Fig. 1. Liver cholinesterase enzyme activities of rats exposed to Dimethoate, an organophosphorus pesticide. *Statistically significant difference from control (p≤0.05) (Sayım, 2007a)



a **b** **c**

Fig. 2. Testicular sections of rats **a)** control **b)** exposed to 8 mg/kg and c) 20 mg/kg Dimethoate. (b, c) shows seminifer tubule degeneration; atrophic tubule. **v**: shows vacuolization in sertoli cells

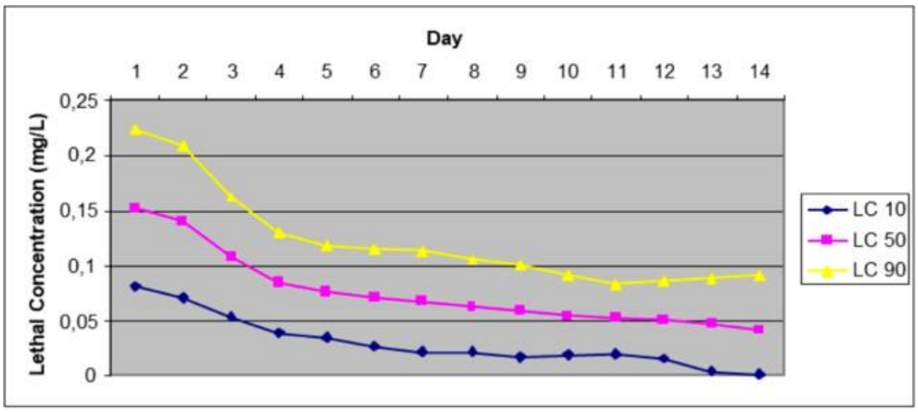


Fig. 3. Toxictiy profile curves of Cu^{+2} for *B. bombina* from larval-toxictiy tests

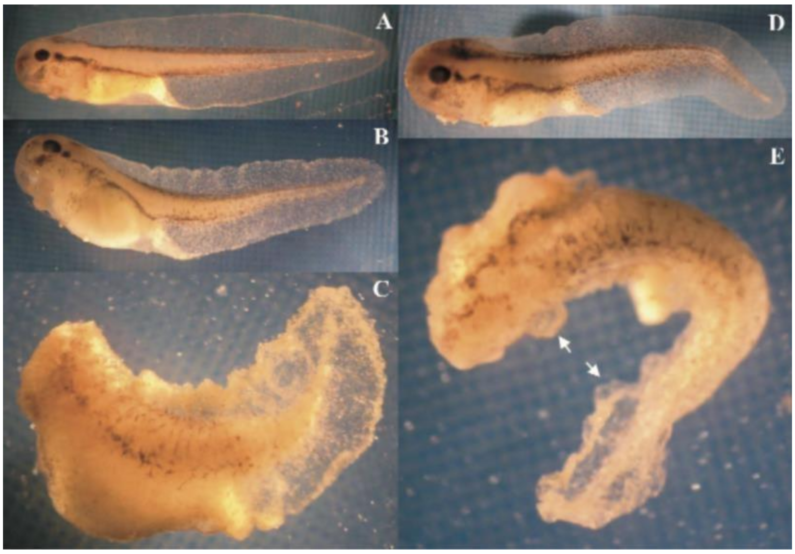


Fig.4. (**A**) Lateral view of a control larva (Stage 23); (**B**) (**C**) lateral view, (**D**) dorsa- lateral view and (**E**) dorsal view of trifluralin-treated larvae at the end of 120 h experimental period of embryo-toxicity test. (B) Minor axial abnormality in which the tail is slightly dorsally curved (Stage 22). (C) Dorsal tail flexure and wavy tail fin. Also, note that delayed development is evident (Stage 19). (D) More complex axial abnormality in which the distal portion of the tail is flexed ventrally (Stage 22). (E) Severe lateral tail flexure and wavy tail fin (Stage 21). Note the edema (è)

3. Conclusion

Innovative implementations in bioassay methodologies, such as BOMBITOX which is modified toxicity test model employing native amphibian species, have been enhancing the accuracy and efficiency of ecotoxicological assessments contributing to the protection of environmental health and biodiversity against increasing environmental challenges.

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