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Utility of cockroach as a model organism in the assessment of toxicological impacts of environmental pollutants

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ABSTRACT

Environmental pollution is a global concern because of its associated risks to human health and ecosystem. The bio-monitoring of environmental health has attracted much attention in recent years and efforts to minimize environmental contamination as well as to delineate toxicological mechanisms related to toxic exposure are essential to improve the health conditions of both humans and animals. This review aims to substantiate the need and advantages in utilizing cockroaches as a complementary, non-mammalian model to further understand the noxious impact of environmental contaminants on humans and animals. We discuss recent advances in neurotoxicology, immunotoxicology, reproductive and developmental toxicology, environmental forensic entomotoxicology, and environmental toxicology that corroborate the utility of the cockroach (*Periplaneta americana, Blaptica dubia, Blattella germanica* and *Nauphoeta cinerea*) in addressing toxicological mechanisms as well as a sensor of environmental pollution. Indeed, recent improvements in behavioural assessment and the detection of potential biomarkers allow for the recognition of phenotypic alterations in cockroaches following exposure to toxic chemicals namely saxitoxin, methylmercury, polychlorinated biphenyls, electromagnetic fields, pharmaceuticals, polycyclic aromatic hydrocarbon, chemical warfare agents and nanoparticles. The review provides a state-of-the-art update on the current utility of cockroach models in various aspects of toxicology as well as discusses the potential limitations and future perspectives.

1. Introduction

The widespread incidence of environmental pollutants due to human activities related to improper discharge of industrial wastes, agrochemicals, wastewater treatment plants, sewage sludge and untreated landfills pose serious risks to the ecosystem and the human health globally (Khan et al., 2021, Sharma et al., 2021). Particularly concerning are the health risks associated with elevated levels of heavy metals, fertilizer-based chemicals, pesticides, pharmaceuticals, nanoparticles and microplastics which have been classified to be neurotoxic, hepatotoxic, teratogenic, endocrine disruptors, and immune modulators based on their mechanisms of toxicity (Luo et al., 2020). Exposure of organisms to several types of xenobiotics can occur at any stage of lifecycle (gestation, infancy, toddlerhood, childhood, adolescence, adulthood, middle age, and the aged), with some stages being more sensitive than others. Moreover, the degree of toxicity also varies with the organism's position within its food web because bioaccumulation due to organism's storage of toxicants in fatty tissues may ultimately create a trophic cascade and the biomagnification of the toxicants (Adeel et al., 2021). Therefore, with the growing rate of environmental problems, there is an urgent need for detection of environmental contamination levels and the delineation of toxicological mechanisms associated with their exposure in order to provide immediate health solutions for both humans and animals.

The significant contributions of different animal models to toxicology research have been demonstrated in unravelling the toxicological mechanisms of drugs, biological therapeutics, chemicals and environmental pollutants in humans and animals. The usefulness of such animal

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