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Mortality of embryos, developmental disorders and changes in biochemical parameters in marsh frog *(Rana ridibunda)* tadpoles exposed to the water-soluble fraction of Kazakhstan crude oil and O-Xylene

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ABSTRACT

The effects of different concentrations of water-soluble fraction of crude oil (WSFO) from the Zhanazhol oil field (Aktobe region, Kazakhstan) and compared to o-xylene, prevalent in this oil, on growth and development of marsh frog *(Rana ridibunda)* were assessed. In subchronic experiments (7 d), a dose-related increase in mortality and incidence of deformities in embryos were observed. In chronic experiments (60 d; starting from the Gosner stage 26), a dose-dependent decrease in body weight, size and developmental delay by 3–4 stages were also detected. In addition, the content of lipid hyperoxide (LHO) and malondialdehyde (MDA), as well as activities of superoxide dismutase (SOD) and catalase (CAT) enzymes in liver of the tadpoles were determined at the end of chronic experiment. Exposure to 0.5 mg/L or 1.5 mg/L WSFO elevated the content of LHO by 76% and 86%, and MDA by 47% and 58% but decreased SOD activity by 26% and 49%, and CAT by 35% and 46%, respectively. A less pronounced adverse effect was found after chronic exposure to the same concentrations of o-xylene. In tadpole liver exposed to o-xylene levels of LHO was increased by 40% and 51%, MDA by 11% and 29%, while the activity of SOD was lowered by 18% and 41%, and CAT – by 13% and 37% in the 0.5 mg/L and 1.5 mg/L treatment groups, respectively. Data demonstrated the embryotoxic and teratogenic effects attributed to WSFO and o-xylene exposure which may involve oxidative stress mechanisms.

KEYWORDS

Rana ridibunda; water-soluble fraction of oil; o-xylene; development; oxidative stress

Introduction

The increasing global demand and growth of oil production and processing lead to increased environmental pollution by associated waste (Wu et al. 2014). Kazakhstan holds approximately 2% of the world's oil reserves, and oil production in recent years was approximately 18% of the GDP (Akhmadi Invest 2016). Thus, vast territories of the country are under development for oil and gas production. A consequence of this process is deterioration of the ecosystems in oil-producing regions (Askarova and Mussagaliyeva 2014). Intensive pollution of the environment by oil and petroleum products leads to the reduction of natural animal populations and the decrease in biodiversity (Kolesnikov et al. 2011; Neuparth et al. 2014). According to national ecological reports (Unified Environmental Internet Resource 2018), the content of petroleum products in waters of the country may be up to 36-fold higher than the maximum permissible concentrations in water (MPCW) (Ministry of Fisheries of the USSR 1990). Thus, assessment of toxicity of oil is highly relevant.

There are a number of toxicological studies of oil and petroleum products in Kazakhstan (Mahmoud, Shalakhmetova, and Umbayev 2012; Shalakhmetova, Mahmoud, and Umbayev 2012; Shalakhmetova et al. 2015; Shametov et al. 2015; Suvorova et al. 2015), but most of these investigations were conducted with either lab rodents (rats, mice) or natural rodent populations inhabiting the oil-producing regions, such as great gerbil (*Rhombomys opimus*) or yellow ground squirrel (*Spermophilus fulvus*). Many oil-producing regions in Kazakhstan contain numerous rivers and small lakes, hence these waterways may be contaminated by oil hydrocarbons; however little is apparently known regarding potential impacts on aquatic ecosystems. Due to their biological characteristics, such as

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