Chinese Journal of Oceanology and Limnology
Vol. 34 No. 1, P. 109-117, 2016
http://dx.doi.org/10.1007/s00343-015-4392-3

Effects of a low-radiotoxicity uranium salt (uranyl acetate) on biochemical and hematological parameters of the catfish, *Clarias gariepinus**

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Received Dec. 24, 2014; accepted in principle Feb. 25, 2015; accepted for publication Mar. 22, 2015

Abstract Specimens of *Clarias gariepinus* were treated with lethal (70, 75, 80, 85, 90, and 95 mg/L) and sub-lethal concentrations (8, 12 and 16 mg/L) of uranyl acetate, a low-radiotoxicity uranium salt. The LC_{50} value was registered as 81.45 mg/L. The protein and glycogen concentrations in liver and muscles were decreased in the fish exposed to sub-lethal concentrations. The red blood cell (RBC) and white blood cell (WBC) counts, haemoglobin (Hb) concentration and haematocrit (Hct) values were decreased. Different blood indices like mean corpuscular volume (MCV), mean corpuscular haemoglobin (MCH) and mean corpuscular haemoglobin concentration (MCHC) were negatively affected. Level of plasma glucose was elevated whereas protein was decreased. The level of calcium concentration (Ca) was declined in the blood of exposed fish whereas magnesium (Mg) remains unchanged. The activity level of glutamic-oxaloacetic transaminase (GOT) and glutamic-pyruvic transaminase (GPT) was elevated in exposed fish. These effects were more pronounced in the last period of exposure and in higher concentrations. Results of the present study indicate that uranyl acetate has adverse effects on *Clarias gariepinus* and causes changes in the biochemical and hematological parameters of the fish.

Keyword: *Clarias gariepinus*; uranyl acetate; sub-lethal concentration; biochemical and haematological parameters

1 INTRODUCTION

In recent years environmentalists have raised concerns about the accumulation of radioactive substances in the bodies of animals and its consequences in the atmosphere and water. Testing of atomic weapons adds anthropogenic radioactivity to the naturally present radioactivity. The use of atomic energy for peaceful purposes, such as generation of power, is being encouraged because of the curtailment in the supply of fossil fuels and the prevailing energy crisis. Realistically, environmentalists anticipate an increase in the output of radioactive wastes. Hence, strong effort should be made to monitor the environmental implications and to furnish advice for effective safeguards in the interest of public health. Strontium, cesium, radium, plutonium and uranium are common radioactive elements that enter the environment through waste disposal or fallout, and influence the aquatic fauna. Strontium and uranium enter the fish body through the intestine, gills and skin, and accumulate chiefly in the bones and to a smaller extent in the viscera, gills and muscles (Nikolsky, 1963; Goulet et al., 2011). These radionuclides interfere in the calcium metabolism in the bones. Rice et al. (1965) studied the dynamics of strontium accumulation in the gold fish. Accumulation of radioactive elements (uranium, radium, plutonium, cesium) and their effects on biological processes of fish and shellfish have also been documented by Cambray and Bakins (1980); Hamilton (1980); Shekhanova (1980); Guéguen et al. (2006); Darolles et al. (2010). Several studies have assessed the effect of uranium salts on fish and other animals, and their possible consequences on human health (Stearns et

* Supported by the Deanship of Scientific Research at King Saud University (No. PRG-1436-011)
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al., 2005; Periyakaruppan et al., 2007; Zymmerman et al., 2007; Priyamvada et al., 2010; Vicente-Vicente et al., 2010; CCME, 2011; WWSA, 2011; Amer and Alwachi, 2012; Daraie et al., 2012; Ahmad, 2014). Many investigators, in the past, focused on the effect of uranyl acetate on the biochemical, hematological and immunological parameters of fish and other laboratory animals (Domingo, 2001; Abou-Donia, 2002; Yazzie, et al., 2003; Goldman et al., 2006; Hartsock et al., 2007; Ahmad, 2014). Accumulation of depleted uranium and its effect on oxidative stress in fish tissues has been reported by Barillet et al. (2007) and by D'Ilio et al. (2007). Simon et al. (2014) have studied the reproductive development in *Danio rerio* under the influence of low (20 μg/L) and moderate (250 μg/L) doses of uranium. Depleted uranium contamination might be pathogenic by suppressing defense mechanism or inducing hypersensitivity in zebra fish, as reported by Gagnaire et al. (2014). Fish are an important human food source; so it is likely that when uranium or its breakdown products are accumulated in fish tissue, these radioactive isotopes will enter the human body. The high tolerance of fish to uranium salts and its long half-life (7×10^8 years) raise concerns about this alarming situation. These contaminants in fish persist for relatively long periods and this is one reason why humans are particularly vulnerable to radioactive compounds. The physiological change in animals caused by toxicant will be reflected in the values of one or more hematological parameters (Van Vuren, 1986). In fish, exposure to chemical pollutants can induce either increase or decrease in the level of hematological parameters. Fish blood is being studied increasingly in toxicological research and environmental monitoring as a possible indicator of physiological and pathological alterations as well as disease in fishery management and aquaculture (Mulcahy, 1975). Furthermore, the investigations pertaining to the tracking down biochemical and hematological abnormalities in the fish can provide indication of exposure to pollutants before any gross signs become apparent. Hence they serve as reliable indices of fish health. Furthermore, biochemical and hematological responses provide cues regarding the type and level of pollutants in the environment (Rao, 2010). The objective of present study was to evaluate the changes in the commercially important fish, *Clarias gariepinus*, exposed to uranyl acetate. Effects on plasma protein, glucose, glutamate oxaloacetate transaminase (GOT), glutamate pyruvate transaminase (GPT) levels, red blood cell (RBC) and whit blood cell (WBC) counts, hemoglobin concentration and hematocrit values were investigated. Levels of protein and glycogen in the liver and muscle of the fish were measured. Concentrations of Ca and Mg in the plasma of fish were also measured.

2 MATERIAL AND METHOD

Specimens of *Clarias gariepinus* (Total length 20–23 cm and total body weight 55–60 g) were obtained from fish farm located at Mozahmiah, north-west of Riyadh. The fish were acclimatized to laboratory conditions for three weeks, during which period they were fed a commercial fish food twice daily to satiety. After preliminary trials, ten fish specimens were kept in each of six aquaria and subjected to different concentrations (70, 75, 80, 85, 90, 95 mg/L) of uranyl acetate dihydrate [UO_2 $(CH_3COO)_2$ $2H_2O$] obtained from Sigma-Aldrich, England, for 96 hours. The normal commercial stocks of uranyl acetate prepared from depleted uranium have a typical radioactivity of 0.37–0.51 microcuries/g. This is a very mild level and is not sufficient to be harmful, while material remains external to body (Wikipedia-en.wikipedia.org/wiki/uranyl_acetate). The necessary safety measures were adopted during the experiment. A parallel control was performed with uranium-free water. Mortality of fish in each concentration was observed after every 24 hours and the number of dead fish was recorded. The medium in the aquaria was renewed daily. The experiment was run in triplicate. The LC_{50} value for 96 hours was deduced from the graph made between probit of kill and $\log_{10}$ concentration of uranyl acetate as suggested by Finney (1971). The mean temperature, pH, dissolved oxygen, and hardness of water determined weekly, were 22.5±0.5°C, 7.8±0.7, 7.2±0.6 mg/L and 230.5±5.23 mg/L, respectively.

In another set of experiment fish were exposed to three different sub-lethal concentrations selected as 10%, 15% and 20 % of the LC_{50} (8, 12 and 16 mg/L) of uranyl acetate for 3 weeks. At the end of every week, 3 fish from each treatment and the control were removed, and their blood samples were collected by excising the caudal peduncle. This is an easy method to collect the blood from small and medium sized fishes. Heparinized vials were used for the collection of blood samples. In case of insufficient quantity, the blood of two or more fish was pooled. Cyano-methemoglobin method (Blaxhall and Daisley, 1973) was used to estimate the hemoglobin. Hematocrit values were determined by using a micro-hematocrit