

Effect of Sub-lethal Concentrations of Endosulfan on Phagocytic and Hematological Parameters in Nile Tilapia (*Oreochromis niloticus*)

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Abstract The effect of endosulfan (6,7,8,9,10,10-hexachloro-1,5,5a,6,9,9a-hexahydro-6,9-methano-2,4,3-benzodioxathiepin-3-oxide), an organochlorine pesticide, was evaluated on phagocytic (phagocytic index and percentage of active cells) and hematological parameters in Nile tilapia. Experimental data showed that an acute exposure to endosulfan (4.0 and 7.0 µg/L) induces a significant decrease in the phagocytic index and the percentage of active cells in peripheral blood of Nile tilapia. However, hemoglobin concentration (Hb), hematocrit (Hto), red blood cell count (RBC), mean corpuscular volume (MCV), mean corpuscular hemoglobin (MCH), and mean corpuscular hemoglobin concentration (MCHC) were not significantly altered in fish exposed to endosulfan compared with control group.

Keywords Endosulfan · Nile tilapia · Hematology · Immunotoxicity

Endosulfan (6,7,8,9,10,10-hexachloro-1,5,5a,6,9,9a-hexahydro-6,9-methano-2,4,3-benzodioxathiepin-3-oxide) is an organochlorine insecticide of the cyclodiene subgroup,

which is commonly used for a wide variety of food crops. However, the substance is highly toxic to non-targeted organisms (Ayub et al. 2003). Effluents of agricultural process may contain elevated levels of chemicals, such as pesticides, which will probably pollute the aquatic environments and induce alterations in fish (Hemmer et al. 2001). Consequently, contamination caused by pesticides, particularly endosulfan, may provoke mass mortality of fish and other aquatic species (Van Dyk and Greeff 1977).

Blood reflects the patho-physiological status of the body; therefore, blood parameters are important in diagnosing the structural and functional status of organisms exposed to toxic substances (Jenkins et al. 2003; Luskova 1996). Another physiological system frequently affected by pesticides is the immune system, particularly the innate mechanisms of the immune response, such as phagocytosis. This is a fundamental mechanism that eventually causes the destruction of pathogens (Neumann et al. 2001). Therefore, the alteration of phagocytic and other immune processes by exposure to pesticides could increase the susceptibility of the organism to infections.

Little information exists on the sub-lethal toxicity of commercial formulations of endosulfan on fish, and specifically, its biological effects on Nile tilapia (*Oreochromis niloticus*), a worldwide economically important freshwater fish (Fitzsimmons 2000). Some studies have shown the presence of endosulfan in aquatic ecosystems, where *O. niloticus* and other tilapia species can be found. Furthermore, accumulations of this pesticide have been shown in tissue samples of the mentioned species (Caldas et al. 1999; Zhou et al. 1999). The present study was carried out in order to determine the effect of sub-lethal concentrations of endosulfan (Thiodan 35 CE) on hematological parameters including: erythrocytes count, hemoglobin, hematocrit, mean corpuscular volume (MCV), mean corpuscular

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