The effects of chronic pulp mill effluent exposure on phagocyte function in juvenile chinook salmon (*Oncorhynchus tshawytscha*)

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Extended Abstract

Juvenile chinook salmon were exposed to 16%, 8%, 4%, 2%, and 0% (control) pulp mill effluent for 30 days under both normoxic and hypoxic (67% oxygen saturation) conditions. The experiments were performed in a portable lab at the Northwood Pulp Mill near Prince George, B.C., Canada. Fish were maintained in water pumped directly from the Fraser River. Pulp mill effluent was pumped directly from the final treatment pond of the Northwood Pulp Mill, cooled, and mixed to give the above concentrations. Three experiments were performed: a) a hypoxic experiment in 200 l flow-through tanks with both normoxic and hypoxic control groups; b) a normoxic experiment in 200 l flow-through tanks; and c) a normoxic experiment in small

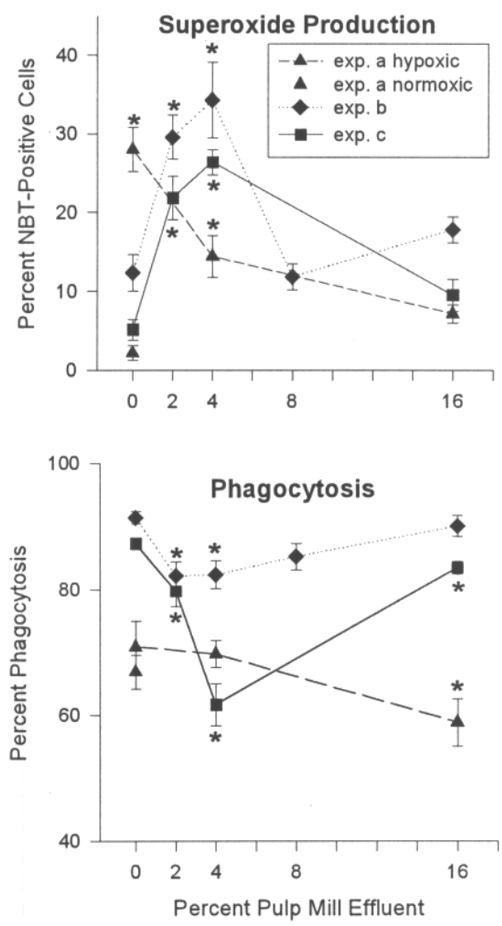

Figure 1. Phagocytosis and superoxide production of anterior kidney phagocytes isolated from juvenile chinook salmon exposed to several concentrations of pulp mill effluent. * different from controls at $p<0.05$, n=8

flow through donut tanks in which water was circulated with a pump to create a current. In experiment a) phagocyte function was measured in the 16%, 4% group, and both control groups, in experiment c) phagocyte function was measured in the 16%, 4%, 2% and control group, and in experiment b) phagocyte function was measured in all treatments. Phagocytes were isolated using discontinuous percoll gradients and adherence to glass slides. Superoxide was measured with a slide assay of nitroblue tetrazolium (NBT) reduction and phagocytosis was measured with a slide assay using yeast as a target particle. Experiments were performed from January to March and the water temperature was 0.3°C.

The number of NBT positive cells was significantly elevated in the hypoxic control group compared to the normoxic control group. The number of NBT positive cells was also significantly elevated in the 4% group compared to the normoxic control group, but only about half as much as the hypoxic control group. The number of NBT positive cells in the 16% group was not significantly different from the normoxic control group. In both normoxic experiments the number of NBT positive cells was significantly increased in the 2% and 4% groups but not in the 8% and 16% groups (figure 1.).

Phagocytosis was not significantly different in the hypoxic control fish compared to the normoxic control fish, however, both of these control groups were lower than the control groups from the two normoxic experiments. Under hypoxic conditions phagocytosis was significantly reduced in the 16% group, but not in the 8% group. Phagocytosis was significantly reduced at all three concentrations of pulp mill effluent in the normoxic donut experiment, however, phagocytosis was only reduced significantly in the 2% and 4% groups in the normoxic tank experiment and not in the 8% and 16% groups (figure 1.).

Phagocytosis results show a similar pattern to the NBT results with the greatest effects seen at the lower concentrations. The lack of effects at the higher concentrations may indicate that the system is overwhelmed and unable to respond or that the system has returned to normal sooner after the initial exposure. Changes detected in these assays indicate that pulp mill effluent does have an effect on the immune systems of the fish exposed to it even at very low concentrations. Any change in the immune system has the potential for compromising the fishes resistance to disease. The fact that the greatest effects were seen at the lowest concentrations is important since these are the concentrations that the fish are more likely to encounter in the wild.

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