World Aquaculture 2010, San Diego, California, March 1-5, 2010.

ACCUMULATING NITRATE-NITROGEN AND ITS POTENTIAL IMPACT ON RAINBOW TROUT *Oncorhynchus mykiss* CULTURED IN LOW AND NEAR-ZERO EXCHANGE RECIRCULATING AQUACULTURE SYSTEMS

John Davidson*, Steven Summerfelt, Chris Good, and Carla Welsh

The Conservation Fund's Freshwater Institute
1098 Turner Road
Shepherdstown, WV 25443
j.davidson@freshwaterinstitute.org

Very little research has been conducted regarding the toxicity of nitrate-nitrogen to salmonids. The most relevant paper, Westin (1974), determined that the 96-hr and 7-day LC50's for rainbow trout fingerlings were 1,360 and 1,060 mg/L nitrate-nitrogen. These levels are relatively high and are typically not reached in most aquaculture systems; therefore, aquaculturists generally ignore nitrate-nitrogen as a potentially toxic parameter. Despite the relatively high LC50 concentrations, Westin concluded that nitrate-nitrogen should be kept at $1/10^{th}$ of the lethal concentration to avoid chronic toxicity and ensure an optimal culture environment. Thus, the maximum recommended concentration is actually much lower, i.e. approximately 100 mg/L.

In RAS that are operated at low water exchange rates water quality constituents, including nitrate-nitrogen, are not readily diluted and thus accumulate within these systems. Therefore, a series of studies are being conducted at the Freshwater Institute to identify potential accumulating water quality parameters that could limit rainbow trout performance (i.e. growth, health, and survival) within replicated RAS that are operated at low and near-zero water exchange with high feed loading rates. The 9.5 m^3 RAS used during these studies utilized fluidized sand biofilters that provided efficient nitrification, thus converting the majority of total nitrogen to nitrate-nitrogen. However, the RAS were not equipped with unit processes designed for denitrification, thus nitrate-nitrogen was allowed to accumulate.

During study 1 and 2 RAS were operated with 0.26% water exchange, i.e. 380 L/min of recirculated water and 10 L/min of continuously added make-up water. The mean nitrate-nitrogen concentration during study 1 and 2 was 84 ± 3 and 99 ± 7 mg/L. During study 2 three RAS were also operated at high exchange, i.e. 2.6% of the total flow. The nitrate-nitrogen reflected the ten-fold difference in dilution within high exchange RAS, i.e. 13 ± 0 mg/L. No obvious fish health problems were noticed during these studies. However, during studies comparing RAS operated at low and high exchange, rainbow trout were observed swimming at a much faster rate within low exchange RAS, as if agitated by something within the culture water. During a third study in which RAS were operated at near-zero exchange, mean nitrate-nitrogen was 384 ±13 mg/L and maximum nitrate-nitrogen reached 600-700 mg/L. Fish within RAS with these elevated nitrate levels appeared to be in distress and exhibited behavior similar to that reported by Westin during acute toxicity events. Mortality was significantly greater within RAS with elevated nitrate and fish appeared to exhibit increased levels of deformity, i.e. severely curved spines. Correlations between nitrate-nitrogen, mortality, deformities, and swimming speed were evidenced by the data and will be reported. Further research is necessary to determine chronically toxic levels of nitrate nitrogen for salmonids cultured within RAS.

World Aquaculture 2010, San Diego, California, March 1-5, 2010.