Trial Report

Ammonium and Nitrate Tolerance in Burbot (*Lota lota* L.)

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Introduction

Since a few years, burbot has been introduced as a new aquaculture species in Belgium for both flow-through and recirculating aquaculture systems (RAS). While this fish species can be successfully cultured in RAS, its tolerance towards ionized ammonium (NH_4^+) and nitrate (NO_3^-) is unknown. The effects of toxic un-ionized ammonia (NH_3) are well-studied for several aquaculture species, but the chronic effects of elevated ionic NH_4^+ concentrations are unknown. Low concentrations of NO_3^- are regarded as non-toxic to fish. However, the tolerable NO_3^- concentration is species-specific. Chronic exposure to high levels of NO_3^- can cause negative effects in fish, such as stunted growth. The tolerable threshold for NO_3^- for burbot is unknown. In order to adequately dimension the biological filter capacity and the required amount of water exchange for a commercial farm, it is crucial to identify the maximum tolerable NH_4^+ and NO_3^- concentrations for this species. We conducted two experiments in order to evaluate the effect of elevated NH_4^+ and NO_3^- concentrations on burbot growth performance and mortality.

Ammonium tolerance

Materials & Methods

Burbots (*Lota lota* L.) with an average body weight (ABW) of 47.11 ± 7.97 g were stocked in 15 aquaria (50 liter each) at a stocking density of 30 fish per aquarium (stocking density = ~28 kg/m³). A flow-through system was used to ensure a proper water quality. Aeration was provided using an air stone connected to an air pump. The fish were exposed to two NH_4^+ concentrations: 0.09 ± 0.22 mg.l^{-1} and 1.94 ± 0.48 mg.l^{-1}. Both treatments were performed in triplicate. NH_4^+ concentrations were maintained at the desired level by automatically adding a NH_4Cl solution with a peristaltic dosing pump (Ismatec Ecoline ISM1089C). Water temperature was maintained at 20 °C. Fish were fed daily with trout feed (Aqua Bio HEX 2 mm). The burbots were raised in these conditions for 48 days and weighed and measured every 2 weeks.

Results

Burbots reared at high and low NH_4^+ concentrations showed specific growth rates (SGR) of 0.80 ± 0.13 %.day^{-1} and 0.77 ± 0.16 %.day^{-1} respectively. Survival was 96.67 ± 5.77% in the high NH_4^+ treatment and 94.44 ± 5.09% in the low NH_4^+ treatment. We observed no significant effects of the elevated NH_4^+ concentration on growth performance (figure 1) or mortality.

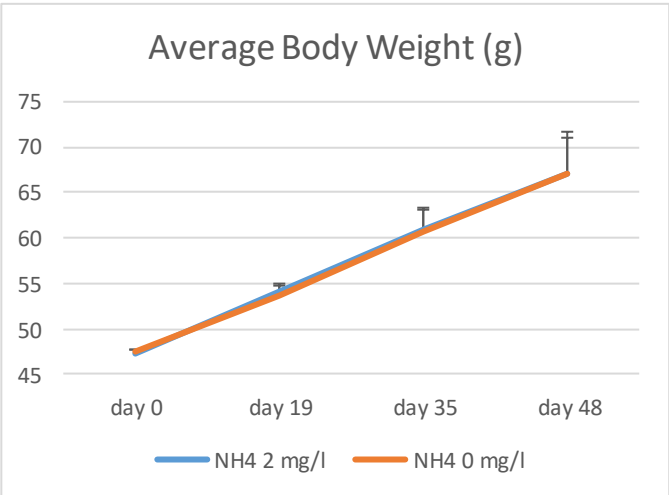

Figure 1. Average body weight in two NH_4^+ concentrations

Conclusion

Under the experimental conditions, an NH_4^+ concentration up to 1.94 mg.l^{-1} did not affect burbot growth performance or mortality during a 48-day period. Based on these observations, we assume this level of NH_4^+ is safe for burbot grow-out in RAS, providing the formation of toxic NH3 is avoided by suitable water quality management. In order to determine the maximum NH_4^+ tolerance for burbot, the impact of exposure to higher concentrations should be tested.

Nitrate tolerance

Materials & Methods

Burbots (*Lota lota* L.) with an average body weight (ABW) of 11.94 ± 0.23 g were stocked in 15 aquaria (50 liter each) at a stocking density of 15 fish per aquarium (stocking density = ~3.6 kg/m³). Each aquarium was connected to a canister filter (Eden 511), providing mechanical and biological filtration. The water was aerated using an air stone connected to an air pump. Water temperature was maintained at 20 °C. Fish were fed daily with trout feed (Aqua Bio HEX 2 mm)

The fish were exposed to three NO_3^- concentrations (each treatment was performed in triplicate):

- low nitrate concentration (LNC): 0-50 mg.l^{-1}
- medium nitrate concentration (MNC): 150-200 mg.l^{-1}
- high nitrate concentration (HNC): 300-350 mg.l^{-1}

The burbots were raised in these conditions for 56 days. Water quality was monitored daily. Water was exchanged every two days to maintain the desired NO_3^- levels. Every two weeks, the burbots were weighed and measured.

Results

The fish showed similar average body weights in all treatments up to week 6 (see figure 2). By the end of the experiment (week 8), growth had declined in the MNC and HNC treatments, with HNC resulting in the lowest average body weight and SGR (see figures 2 and 3). Survival was 97.8 ± 3.9% in all treatments.

Conclusion

Chronic exposure to elevated nitrate levels appears to affect growth rate in burbot. An eight week exposure to NO_3^- concentrations up to 350 mg.l^{-1} did not affect survival rate. According to our results, burbot should not be exposed to elevated NO_3^- concentrations for more than four weeks, in order to avoid negative effects on their growth performance. Highest growth rate was achieved at NO_3^- concentrations of less than 50 mg.l^{-1}.

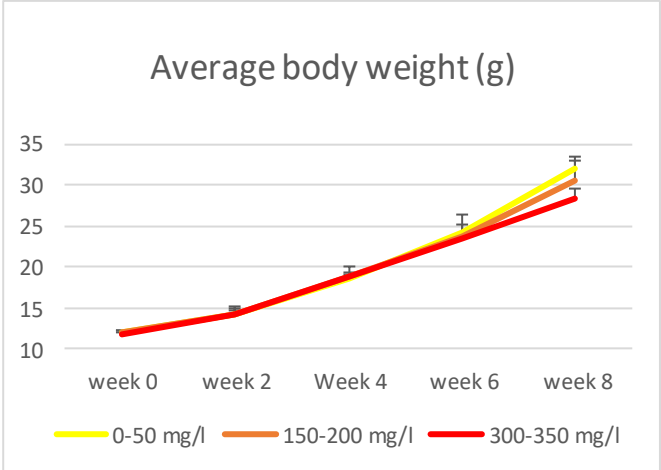

Figure 2. Average body weight in three NO_3^- concentrations

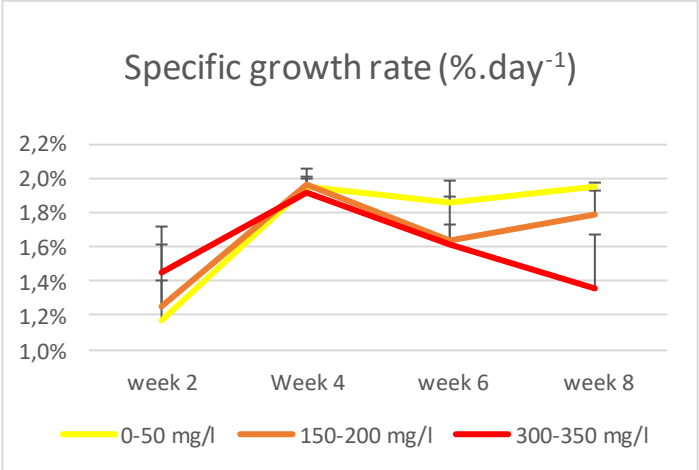

Figure 3. Specific growth rate in three NO_3^- concentrations