LONG-TERM EFFECTS OF PH AND CARBON DIOXIDE ON GROWTH AND FEED EFFICIENCY IN EUROPEAN SEABASS

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Under intensive rearing conditions and particularly when the water is re-used, ambient pH and carbon dioxide concentrations may reach high levels that limit fish survival and growth. The main aim of the two following long term experiments was to identify separately the effects of pH and CO_2 concentrations on the feed intake (FI), the specific growth rate (SGR), and feeding conversion ratio (FCR) in seawater.

In the first experiment, 125g seabass (*Dicentrarchus labrax*) were exposed in $1m^3$ tanks by triplicates to five levels of pH for 63 days in an open flow system :5.3, 6.1, 7.0, 7.9 (control) and 8.9. High and low pH levels were obtained by adding a continuous and adapted delivery of concentrated acid or soda solutions. Fish were fed by a self-feeding system and ingested food was quantified daily. Light intensity was 250 lux and photoperiod 16L-8D with a 30 min artificial dawn and dusk. Water temperature was 21.8°C and water was aerated enough to remove CO_2 in excess (below $5mg.l^{-1}$ CO_2 for the lowest pH level), oxygen was above 85% of saturation level and salinity was 37.1‰. No mortality occurred at any pH. Abnormal behaviour was recorded at pH 5.3 as hyperventilation, erratic swimming and loss of reflex. The fish did not feed during the first 21 days and lost weight. After 63 days, the maximum FI and SGR recorded at pH 7.0 were respectively 8 and 11.8% higher than the control. No difference was found between control groups and pH 6.1 level. The highest FCR values observed in the 2 extreme conditions were partly due to a lower FI.

In the second experiment, 115g seabass were exposed in $1m^3$ tanks by triplicates to five levels of dissolved CO_2 for 63 days in an open flow system :0.8 (control), 9, 18, 35 and $75mg.l^{-1}$ CO_2. Consistent values of pH were respectively 7.9 (control), 7.3, 6.9, 6.5 and 6.2. The different CO_2 levels were obtained by adding continuous and adapted flows of CO_2 enriched seawater. Fish were fed by hand *ad libitum* twice a day and ingested food was quantified daily. The others conditions were similar to the first experiment. No mortality occurred at any CO_2 level. Abnormal behaviour was recorded at $75mg.l^{-1}$ CO_2 as lethargy, loss of reflex and discoloration. The fish did not feed during the first 10 days and lost weight. After 63 days, the maximum FI and SGR recorded at $9mg.l^{-1}$ CO_2 were respectively 7.8 and 8.6% higher than the control. In the $75mg.l^{-1}$ CO_2 (pH=6.2) condition, FI and SGR were only 32 and 25% of the control and the FCR was twice higher. It was clear that was the only responsible for the . Disorders observed in fish at the highest concentrations were mainly explained by dissolved CO_2. In seabass acclimated to CO_2 for 21 and 63 days, some dose dependent changes in ionic and acid-base balance were observed. Plasma osmolarity and chloride concentration decreased while plasma CO_2 increased dramatically til 400% of the control fish under $75mg.l^{-1}$ CO_2 condition. Blood pH, plasma cortisol and other blood indicators tested were in the normal range for seabass under any ambient CO_2 concentrations.