Welfare aspects of stocking density in farmed rainbow trout, assessed by behavioural and physiological methods

There is an increasing amount of interest in the welfare of fish from aquaculture. There are several aquaculture practices that may act as chronic stressors and therefore have the potential to negatively impact welfare. Stocking density has been highlighted as a particular welfare concern, from both an ethical and practical point of view. A quantity of research has been conducted on the relationship between stocking density and indicators of welfare in farmed rainbow trout Oncorhynchus mykiss. The studies to date have revealed that both low and high densities have the potential to detrimentally affect welfare in rainbow trout. Several studies have endeavoured to make specific recommendations for maximum stocking density limits for rainbow trout. However, wide discrepancies exist, highlighting the fact that it has been a challenge to identify density limits that promote optimal welfare and production in rainbow trout. This emphasises the significance of developing alternative methods that provide insight into the potential density limits that are optimal for welfare and performance in rainbow trout. Here, a behavioural method using two-tank systems was developed and applied. The twotank systems consisted of two identical tanks which were attached to each other with a doorway allowing the fish to move freely between the two tanks. By studying the spatial distribution of fish in two-tank systems stocked with different densities and the neuroendocrine stress levels of the fish, a density level was established that showed indications of crowding. The results revealed that a level of aversion to crowding had been reached at an absolute density of approximately 140 kg m$^{-3}$. Additionally, the influence of the established density limit on physiological indicators of welfare and performance were investigated. At this density of 140 kg m$^{-3}$, the lower oxygen consumption rates and lower quantity of scale loss collected from the tanks suggested reduced levels of social hierarchy related aggressive encounters. Higher brain serotonergic activity in the brain stem of individuals held at this density indicated elevated stress levels, despite low concentrations of plasma cortisol. The reduced energetic expenditure at 140 kg m$^{-3}$ resulted in a better utilisation of ingested feed and hence growth performance. Taken together, despite the chronic stress levels at this density, the results showed that at this density the reduced energy expenditure, attributed to reduced aggressive social interactions, resulted in a better growth performance. Therefore, it may be concluded that application of the method using the two-tank systems provided new insight into an optimal stocking density limit for rainbow trout. Furthermore, the method presented here provides a promising tool for investigating stocking density levels in rainbow trout. Further development of the current method would consider it applicable for determining limits for a range of culture situations.

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