



Popular science summary of the PhD thesis

PhD student	Tilo Pfalzgraff
Title of the PhD thesis	Effects of Cortisol on the Nutrient Utilisation and Bioenergetics of Rainbow Trout
PhD school/Department	DTU Aqua

The welfare of farmed animals attracts more attention than ever. Welfare issues of mammals and birds have already been a public concern for a while but the extraordinary growth of the aquaculture industry in recent decades has also shifted focus on welfare risks associated with fish production. While in the past, fish were believed to be insensitive emotionless animals, continuous research has shown that they are as affected by stress-related issues as terrestrial animals. Aquaculture related issues regarding fish welfare include insufficient water quality, inappropriate stocking densities, inadequate nutrition, crowding, repeated handling, and social stress. Some of these stressors have shown to cause chronic elevation in circulating cortisol levels, the main stress biomarker of teleost fish. While the short-term effects of cortisol on fish metabolism are well studied, less is known about the consequences of prolonged elevated cortisol levels.

The main objective of this Ph.D. project was to contribute to the understanding of how such long-term elevated cortisol concentrations effect the metabolism of rainbow trout. Four studies were conducted to reveal some of the long-term effects of chronic stress on performance related traits. Fish were treated with chronic cortisol implants by means of coconut oil as vehicle that released the hormone into circulation over several weeks. The first study was conducted to test the effect of different temperatures on this hormone application method. The results showed that at lower temperatures, cortisol levels remained constant, while higher temperature caused a faster release of cortisol from the implant resulting in declining cortisol levels over time.

The results of the second study revealed that prolonged cortisol elevation reduces growth rates of rainbow trout, in part, by reducing their digestive capacity. This prevents the fish from obtaining the same amount of energy from the feed they ingest compared to their untreated conspecifics. The digestive underperformance of cortisol treated fish was conceivably caused by a downregulation of the digestive organs.

In the third study, it was found that fish with very high circulating cortisol concentrations had a higher basal mass-specific oxygen consumption, meaning they have a higher energetic cost of living. This was confirmed by the increased oxygen consumption rates of specific organs, suggesting that the fish need more oxygen to supply their tissues with the required energy. The main source of energy for this extra supply came from lipid storages of the fish.

The fourth study tested if cortisol is involved in the commonly observed reduction of digestive tissue mass in starving fish. By inhibiting cortisol to bind to its receptors by means of specific blockers, the fasting-induced elevation in plasma cortisol levels observed in the control group was suppressed. However, this had no impact on the reduction in the mass of the digestive organs or overall weight loss during starvation suggesting that cortisol is not a key player in reducing the gastrointestinal mass in an unfed state.

In conclusion, the work conducted within this project contributed to the understanding of long-term effects of cortisol elevation on the metabolism of rainbow trout. The findings emphasize the importance of fish welfare in aquaculture production, as the effects of chronic cortisol elevation due to stressful rearing conditions might not only affect production related traits such as growth rates of the fish. The decreased ability of fish with high cortisol levels to absorb nutrients will ultimately result in impaired water quality as the nutrients end up in the water as organic matter, which can be utilized for e.g. bacterial growth. A higher buildup of organic matter would directly impact the aquaculture system's carrying capacity and the welfare of the fish.