SWIMMING TO OPTIMIZE PRODUCTION

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Introduction

The basic physiological condition of many fish species of commercial interest is constant movement. Current aquaculture conditions often represent suboptimal environments to allow such behaviour. The stimulation of swimming exercise in aquaculture can therefore offer physiological benefits that are worth the extra costs for inducing a flow and adjusting the systems, and may even represent solutions for well-known aquaculture bottlenecks. Optimal exercise protocols should be developed and end discussions about contrasting results which are obtained at different swimming speeds and other variables that interfere with swimming physiology. In this review, I will present the most recent information coming from our experimental trials which provides input for a discussion on the opportunities to use exercise to farm fit fish under current and future aquaculture conditions.

Swimming exercise to stimulate muscle growth

Numerous studies have shown exercise-enhanced growth of fish, specifically through hypertrophy of the white skeletal muscle and increase of filet mass. Generally, groups of fish are swum in round tanks at several different flow regimes to determine which is the optimal flow for growth. In our studies, we have investigated the effects on growth at the optimal swimming speed, the speed at which fish swim most efficiently (at lowest cost of transport) and which corresponds well with optimal speeds for growth stimulation for several salmonid species and yellowtail kingfish (Davison & Herbert, 2013). First, optimal swimming speeds were determined by respirometry in swim-tunnels. Subsequently, fish were trained for weeks in the swim-tunnels (zebrafish) or in a swim gutter designed as a double-sided raceway thereby retaining fish in a swim compartment and forcing them to swim continuously in a straight line under laminar flow conditions.
The carangid yellowtail kingfish and the cyprinid zebrafish represented positive examples of exercise-enhanced growth. Exercised yellowtails increased their body weight by 46% as compared to resting fish after 18 experimental days (Palstra et al., 2015). Exercised zebrafish increased their body weight by 41% as compared to resting fish after 20 experimental days (Palstra et al., 2010, 2014). The moronid European seabass and the sparid Gilthead seabream did not show exercise-enhanced growth at their optimal swimming speed (Benito, Graziano, Planas, Palstra, unpublished data). In fact, swimmers of both species grew less than the resting fish. In literature, exercise-enhanced growth for seabream has been reported, but at much lower speeds (Sánchez-Gurmaches et al., 2013). Therefore it may well be that seabream and seabass benefit from exercise at lower than optimal swimming speeds.

Swimming exercise to control sexual maturation

Experimental swimming trials with female European eels in fresh water revealed lipid deposition and oocyte growth. Swimming in seawater resulted in suppressed gonadotropin expression and vitellogenesis (Palstra & van den Thillart, 2010). A swimming-induced ovarian developmental suppression was also shown in rainbow trout (Palstra et al., 2010b, 2013). These studies have revealed important insights on the use of swimming exercise to control sexual maturation. We use exercise in combination with other environmental triggers to simulate migration in European eels which enhances the early sexual maturation, a protocol that is applied for brood-stock conditioning e.g. to make farmed eels silver (Mes et al., 2015). On the other hand, we have applied swimming exercise in juvenile male sea bass to prevent precocious sexual maturation (Planas et al., 2015).

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Swimming exercise can thus be applied in aquaculture to accelerate growth and to extend the growth period. Major exercise-induced changes in the muscle composition may have important consequences for flesh quality parameters. Several other applications of swimming exercise may be helpful with solving bottlenecks and deserve more research attention. Exercise training may enhance the immune capacity like in mammals and could be applied to prepare fish for changing conditions and prevent diseases (e.g. when bringing them to sea cages). Critical swimming speed tests can be applied to select good from bad swimmers, for example to select out malformed or ill fish. Finally, we have found that exercise could represent an important tool in protocols that aim to remove the off-flavour causing chemical geosmin more rapidly and efficiently. Altogether, swimming exercise may represent a natural, non-invasive and economical approach to farm fit fish in aquaculture (Palstra & Planas, 2011). We are exploring these opportunities in the COST Action FITFISH.

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