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Review Article

The Stress Response and Fish Welfare in Aquaculture

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In aquaculture, fish can be submitted to several stressors. Besides the inevitable handling at transport, counting, reproduction, etc., which are acute stressors, day-to-day conditions as noises, deterioration of water quality, competition among fish, for example, can act as chronic stressors and be a challenge to fish's welfare and health.

The stress response includes a primary phase, with a fast (in seconds) secretion of catecholamines and the activation of the hypothalamus-pituitary-interrenal axis, which results in secretion of cortisol (in minutes) [1]. This cortisol response can be sustained for hours or even days, depending on the nature of the stressor and if the stressor persists. By action of catecholamines, branchial oxygen uptake and the oxygen transport by blood increases, as well as the cardiac output; the level of blood glucose rises, mostly by glycogenolysis, but also through gluconeogenesis, mainly if hepatic glycogen is depleted [2]. Cortisol effects include the increase of blood glucose levels through gluconeogenesis, mainly using free fat acids as substrate, and also induce lipolysis and proteolysis, releasing substrate to be used in gluconeogenesis; cortisol also impairs the immunological response, which can be energetically costly. In addition to its metabolic effect, cortisol also acts as a mineralocorticoid,

controlling the hydromineral balance in fish, through the uptake (freshwater fish) or extrusion (seawater fish) of ions by the branchial membrane [1].

All these effects of catecholamines and cortisol prepare the animal to a "fight or flight" response, when the resources are allocated to cope with the stressor and secondary demands are impaired [1]. This physiological adjustment is important and highly adaptive when fish is confronted with a stressful situation where an "emergency state" is necessary to survive [3]. The concern is the persistency of the response, as in a chronic stress, leading to deleterious effects as reproduction failure, impaired growth, and depletion of immunological response [2]. In that way, the stress response is not maladaptive per se, but can become disruptive if sustained for a long period.

Once the stress response is not maladaptive, and is necessary for the fish to cope with situations where its homeostasis is challenged, the concern should not be in attenuating the stress response, but on avoiding, as much as possible, the stressors in aquaculture, specially the chronic ones. Good practices considering the welfare of fish should be applied, respecting the biology of the species and their needs in terms of space, nutrition,

and water quality. Also, the fish handling should be made considering that these animals can be sentient. There are growing evidences suggesting that fish can detect and respond to noxious stimuli with behavioral and physiological alterations [4-6] and even that fish can perceive stressors differently based on its psychological state [7]. Although it is not possible to assert that fish feel pain, an ethical approach is treating them as they do, once we cannot prove that they do not feel [8]. In addition, at the economic point of view of aquaculture, to prevent the stress and avoid its deleterious effects are good choices to ensure good performance and minimize production losses.

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