

Fish Health: An Oxidative Stress Perspective

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The precarious status of wild populations all over the world as well as the pressure on aquaculture production to fulfill growing demand of fish protein, entail increasing concerns about fish health. This has led to a boost in research efforts, mainly to find cure to principal pathologies affecting either wild or domesticated species of commercial interest. As a result, a marketing of new diagnostic tools or new drugs has emerged and is expanding. This kind of strategy might sound natural and well sounded: try to fix a problem when it appears, and if there is no problem, don't touch anything. It results from the perception that a healthy fish is a fish without any disease, and this paradigm likely prevailed since the start of the aquaculture industry. However, considering the pressure to improve productivity in fish farms with a relatively low profit margin, we can wonder if this paradigm is still relevant or sufficient.

The aquaculture industry has been remarkably efficient to select fish strains for high economical value characters, particularly for growth rate. In natural populations, growth rate modulation seems to be in equilibrium with modulation of other phenotypic characters often associated with energy metabolism such as longevity. The astonishing increase in growth rate achieved in some species (for example in the Atlantic salmon) likely brought these strains at the edge of their metabolic optimum. To put it simply, selection for the fittest has been substituted by selection for the biggest and often the fattest. This can partly explain the significant decreased lifespan of domestic strains of Salmon for example. Today, an emerging concept to define and monitor the metabolic status of animals and to determine to what extent their phenotype as well as their environment provides conditions sufficient to fulfill their metabolic requirements is oxidative stress. Oxidative stress results from the imbalance between the production of Reactive Oxygen Species (ROS) principally from mitochondria and the ROS buffering activity of some enzymes or other antioxidant molecules (for example tocopherol, ascorbic acid or carotenes among others). Especially, mitochondria seem to be good sensors of the general stress status of the cell or the animal (for example environmental, nutritional or toxic stress), and transduce this status in terms of ROS production level. The impairment of the balance (higher ROS production and/or lower buffering capacity), and therefore the occurrence of oxidative stress, has been related to an increased susceptibility to different environmental or biotic stress and to the development of different types of pathology in different animal species. What is more, most

of the prevalent theories on aging process evoke oxidative stress as a key factor of deleterious cellular condition associated to senescence. Therefore, mismanagement or over-induction of oxidative stress in commercial populations of Atlantic salmon could partly explain their shortened lifespan compared to natural populations.

Here, I therefore suggest that the monitoring of oxidative stress or of the different markers of oxidative stress could be powerful tools to evaluate the metabolic and general health status of fish. This would be a relatively simple procedure to estimate if the selected phenotype as well as the nutritional or environmental conditions they experience allow metabolic optimality at cellular and tissue levels. This new approach could grant development of healthier strains or populations that could better resist stressing, pathogens and diseases and therefore limit chemical and biochemical intervention for curing fish. We could for example include in the selection programs metabolic criteria that guaranty the development of strains with good oxidative stress management ability and higher resistance to biotic and abiotic stress. Monitoring these oxidative stress markers could also be of major interests for the management and conservation of wild populations. Knowing the stress status of populations could for example be highly relevant to reveal the environmental or physiological causes of divergences in growth, survival or recruitment of different populations of one species.

The good news is that we have access to many markers of oxidative stress, which are easily measurable. The next step might be to characterize healthy fish (either wild or domestic fish) to be able to calibrate the markers and to select proper and relevant criteria. Responses to acute stress tolerance would likely be a good start to discriminate the healthiest from the weakest. This approach has already been successfully used, for example by the team of Guy Claireaux in France. Prevention has indeed always yielded greater return on investment than sustained treatment. Unfortunately this kind of research is difficult to get funded principally because we can hardly expect a precisely defined short term benefit for the industry. Considering that, the overall collective benefit not only for our industries, but also for our society and environment could be tremendous. Let's hope that responsible agencies (private and governmental) won't miss this opportunity to develop new tools allowing to sustain healthier resources.

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