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Health benefits from natural sources of astaxanthin and omega-3 fatty acids: Fish oil, algal biomasses, and krill oil

Marcelo Paes de Barros
Cruzeiro do Sul University, Brazil

The regular consumption of marine fish and seafood has been long recommended as a nutritional intervention to preserve general health, including improvement of immune responses, prevention of neurodegenerative diseases, and inhibition of carcinogenic processes. Most of the health benefits provided by marine food consumption comes from an adequate uptake of omega-3 polyunsaturated fatty acids, (n-3)/PUFAs, and the antioxidant carotenoid astaxanthin (ASTA). On the other hand, several studies have given rise to the hypothesis that unbalanced (n-3)/PUFAs consumption could affect the physicochemical properties of biological membranes (fluidity, permeability, hydrophobicity, *etc.*), thereby impacting negatively on cell-cell communication, and, consequently, depressing immunological efficiency, cell proliferation, speed of signal transduction and the effectiveness of neurotransmission. Furthermore, (n-3)/PUFA-overloaded membranes become more sensitive to oxidative injury if not properly counterbalanced by antioxidant compounds, such as ASTA. Therefore, an appropriate redox balance in specific cells/tissues is necessary for optimal metabolic and physiological functions in all organisms. This work focused on the long-term supplementation of ASTA, (n-3)/PUFAs, and their combination from natural sources (e.g. fish oil, algal biomasses and krill oil) in Wistar rats and subsequent redox analyses in immune cells (mostly, neutrophils and lymphocytes), specific brain regions related to anxiety behavior (anterior forebrain) and motor control (cerebellum), in plasma, and soleus muscles of animals submitted to exercise until exhaustion. Finally, new perspectives for a reasonable application of both natural micronutrients will be discussed, based on the well accepted 'hormesis' principle.

marcelo.barros@cruzeirodosul.edu.br

Personalities and welfare of fish in aquaculture

Flavia Oliveira Mesquita
Federal University of Minas Gerais, Brazil

Fish are cultured for a variety of reasons including for food, for the ornamental trade, for restocking and for conservation. Housing animals at high densities and with frequent husbandry interventions are common and necessary practices in aquaculture but it is impossible to avoid many of the procedures known to induce stress in fish. It is important to make husbandry practices less stressful. The impact of aversive stimuli or stressors is determined by the ability of the organism to cope with the situation. Whenever environmental stressors are too demanding and the individual cannot cope, its health is in danger. It is important to understand the mechanisms and factors underlying the individual's capacity to cope with environmental challenges. As is true for other agriculture sectors, aquaculture practices are now being examined to assess their impact on the environment and on animal welfare. There are a number of strategies that could potentially be used to reduce the adverse effects of fish husbandry practices including choosing to farm fish that adapt well to intensive rearing conditions, developing husbandry systems that minimise adverse effecton welfare and developing sensitive indicators that can be used on working farms to identify quickly and easily whether fish are in a state of good welfare. Behavioural responses are the first defence that an animal has against environmental changes, predators or social conflicts. Animals show different behavioural strategies when facing threatening situations and the type of behavioural and physiological response to stress is an individual characteristic called coping or personality.

michaelfaraday2@yahoo.com

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