Nutritional Interventions To Control Oxidative Stress & Promote Optimal Immunity In Aquaculture

The balance between antioxidants and prooxidants in cells is an important determinant of optimal immune response and growth.

Building the antioxidant system aims to avoid an imbalance - the so-called oxidative stress - and has become a priority for nutritionists given the link between production conditions and chronic oxidative stress.

Intensification in aquaculture implies high-stocking densities, excessive accumulation and decomposition of organic waste, as well as water temperatures that are occasionally sub-optimal for the species' physiological condition.

Maximum stability and bioavailability of selenium from feed are important to optimise the selenium-dependent antioxidant mechanisms.

Furthermore, genetic selection aims for maximum growth. However, fast growth also diverts resources away from self-maintenance processes such as antioxidant protection and is associated with excessive prooxidant production. A mechanism of the immune response is the production of prooxidants that contribute to the elimination of pathogens and act as signaling molecules for tissue repair.

However, an overwhelmed antioxidant system will constrain the immune response in an attempt to avoid excessive prooxidant production. The overall outcome is increased disease predisposition and performance below expectations. Thus there is a need for nutritional interventions to reinforce the antioxidant mechanisms and support the immune response.

Micronutrients, such as selenium, manganese and zinc (other than vitamins E, C and A), provide co-factors and substrate necessary for the optimal functioning of the antioxidant system. Selenium participates in the different levels of antioxidant defense and is a clear determinant of animal´s resistance to oxidative stress. It is a co-factor of glutathione peroxidase (GSH-Px), which breaks down and captures prooxidants. Studies in aquaculture species show the more dominant and persistent activity of GSH-Px over other antioxidant enzymes (for example, SOD, CAT) involved in the first line of antioxidant defense.

For maximum antioxidant protection, the nutritionist must ensure the use of an organic selenium source that warrants high stability during feed processing as well as maximum availability to the animal. Data confirms the superior stability of organic selenium based on pure hydroxy-selenomethionine (Adisseo's Selisseo®) under aquafeed extrusion conditions and as compared to other organic sources such as selenium yeast or pure selenomethionine.

A recent publication in rainbow trout has also demonstrated the benefits of hydroxy-selenomethionine over inorganic selenium on tissue deposition as well as GSH-Px expression and activity.

A parallel approach to micronutrient supplementation, which aims to control oxidative stress and promote an optimal immune response, is the use of functional feed additives based on natural antioxidants in combination with immunostimulants. Natural antioxidants can capture prooxidants and thus reinforce the antioxidant defense, while immunostimulants activate immunity and amplify different effectors of the immune response. Two of these effectors are lysozyme and phagocytic activities in blood, which characterise the animal's capacity to break the bacteria cell wall and engulf infectious microorganisms, respectively.

Results have shown that the inclusion of AQUASTIM, a functional feed additive based on immunostimulants and antioxidants, boosts both the lysozyme and phagocytic activities of seabream before and during a simulation of stressful conditions such as winter temperature/photoperiod (Figure 1). Improvements were less pronounced when supplementation was based on pure immunostimulants such as beta-glucans or treated yeast, confirming that efficient enhancement of the immune response is driven not only by the type of the immunostimulant but also by the supply of adjuvant antioxidants. Growth improvement by 10% and a similar immune-enhancing effect was observed in white shrimp supplemented with AQUASTIM, with increased phagocytic activity translating into 50% reduced mortality of Vibrio paneicida infected shrimp (Figure 2).

Chronic oxidative stress resulting from production conditions is detrimental to optimal immunity. The antioxidant requirements to maintain a highly active immune response are high, and nutrition plays a key role to reinforce the antioxidant system and boost the innate immune response.

Meeting the increased requirements of selenium under stress conditions is of specific concern, thus maximum stability and bioavailability of selenium from feed are important to optimise the selenium-dependent antioxidant mechanisms.

Additional support based on natural antioxidants and immunostimulants can reinforce the innate immune response and further ensure optimal disease resistance and performance.

References available upon request (waldo.nuezortin@adisseo.com).

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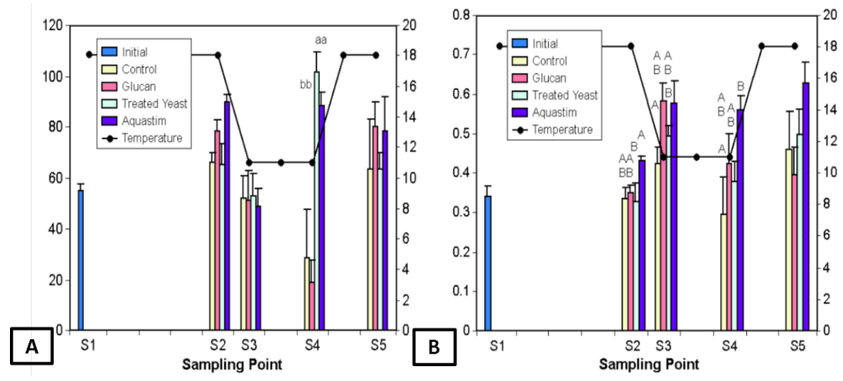

Figure 1. Effect of temperature/ photoperiod ramps on blood immune indicators of gilthead seabream fed different functional feed additives with immune-enhancing properties, including AQUASTIM. Temperature (°C) follows the right axis. A) Lysozyme activity (kunits/l); B) Phagocitosys activity (nmol nbt reduction). Different letters within sampling time denote significant differences at p < 0.05. Trial conducted at the University of Barcelona (Spain).

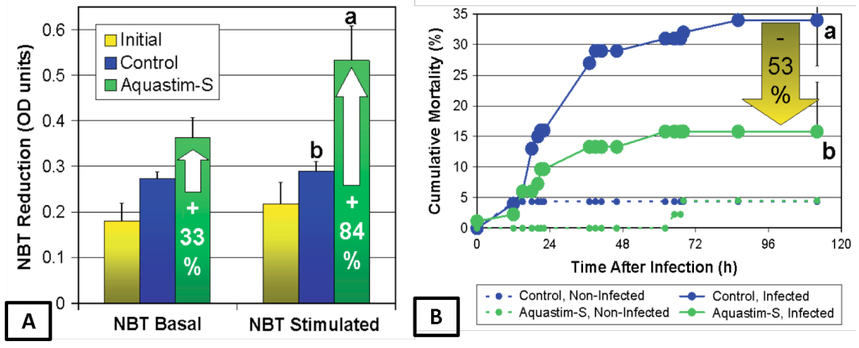

Figure 2. Immune effect of AQUASTIM in white shrimp. A) Evolution of basal (NBTb) and stimulated (NBTs) phagocytosis activity between shrimp acclimated to commercial feed and shrimp fed experimental feeds during 21 days. B) Cumulative mortality (%) in shrimp infected with Vibrio paneicida and fed with AQUASTIM supplemented feed. Different superscripts denote significant differences (Student t-test, P<0.05). Trial conducted at IFREMER (French Polynesia).