Pathological fingerprint of harmful algal blooms in farmed salmon from southern Chile

Oral

Multidisciplinary Studies

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Harmful algae blooms (HABs) have been identified as the cause of large-scale mortalities of salmonids throughout the world. The harmful effects vary by species and may combine hypoxia, mechanical abrasion of branchial tissues, and oxidative injury driven by reactive oxygen species (ROS) and lipid peroxidation.

This study analyzes and compares the effects of harmful algal blooms on Pacific salmon (*Oncorhynchus kisutch*) and Atlantic salmon (*Salmo salar*) during the ongrowing phase in southern Chile (Regions X and XI) between 2009 and 2024. Systematic necropsy and histopathological analysis of different tissues were conducted during each event. Causative blooms were dominated by *Alexandrium catenella* (1-350 cells mL, 2009), *Pseudochattonella cf. verruculosa* (7.000–20.000 cells mL, 2016; 45–300 cells mL, 2024), *Thalassiosira pseudonana* (60.000 cells mL, 2023) and *Heterosigma akashiwo* (48–474 cells *mL, 2024)*

In all cases, the gill constituted the primary lesion site. These ranged from acute to chronic, and were characterized by necrotic, vascular disturbances such as lamellar thrombosis, congestion and oedema; adaptative responses including epithelial hyperplasia, synechiae and goblet cell proliferation and, in chronic cases, reparative

fibrosis. The type and severity of lessions were modulated by algal species, cell density and duration of exposure.

These results highlight the impacts of HABs on salmonids and align with experimental data, confirming ROS-mediated oxidative stress as the central driver of branchial pathology. Continuous phytoplankton surveillance, standardized gill scoring and timely cage relocation are therefore critical for safeguarding animal welfare and mitigating economic losses in Chilean salmon farming.

Palabras Clave

(1) Gill disease, (2) Harmful algae blooms, (3) Fish Pathology.

Financiamiento:

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