Immune response of thiamine deficient Chinook salmon (Oncorhynchus tshawytscha) to columnaris disease

Abstract

The main objective of this study is to investigate the pathogenesis of thiamine deficiency, particularly focusing our attention on the immune response and susceptibility of thiamine-deplete and –replete Chinook salmon fry to columnaris diseases.

We hypothesize that thiamine deficient Chinook salmon are immunodeficient and will be significantly more susceptible to columnaris disease when compared to fish with normal thiamine values.

Introduction

High morbidity and mortality of Chinook salmon (Oncorhynchus tshawytscha) fry has been reported in California’s Central Valley associated with thiamine deficiency (TD). (1)

Thiamine is an essential B vitamin that is required by all living cells for energy metabolism and neurological function. (2)

- A deficiency in thiamine can lead to poor reproductive success, neurologic dysfunction and death. (2, 3)

Flavobacterium columnare is a gram-negative rod shaped bacteria that causes columnaris disease in freshwater fish.

Flavobacterium columnare is ubiquitously distributed in freshwater environments. (2)

- Can result in substantial losses in wild and cultured fish. (4)
- Clinical signs and gross changes include gill necrosis, fin rot, and skin lesions.

The incidence of columnaris disease has increased in the past decade, particularly in the Pacific Northwest. (5)

Methods

120 Thiamine-replete Chinook salmon fingerlings

120 Thiamine-deplete Chinook salmon fingerlings

Exposed to Flavobacterium columnare via immersion

Morbidity and mortality rates monitored 2x per day for 16 days

6 fish sampled from each treatment group at specific time points post-challenge:

- 1 hour
- 1 day
- 2 days
- 4 days
- 6 days
- 8 days
- 16 days (end of challenge)

Gills and spleens collected from each fish

Flavobacterium columnare was quantified in gills and spleen via qPCR (7)

Gills and spleen will be analyzed through reverse transcriptase qPCR for analysis of genes involved in innate and adaptive immune response

Cytokines targeted are:

- IL1β
- TNFα
- IFNy, IL2, IL8, IL10 and TGFB

Diagnosis of F. columnare infection confirmed via qPCR and agar plating of gills and spleen

Survival curve analysis and statistics were performed using GraphPad Prism v.8.3.0.

Statistical significance was determined by Log-rank (Mantel- Cox) and Gehan-Breslow-Wilcoxon tests

Results

Figure 1: Thiamine-deplete Chinook salmon presented with less severe clinical signs and mortality due to columnaris disease throughout the challenge period of 16 days.

Figure 4: Acute mortalities occurred in fish exposed to Flavobacterium columnare. The highest amount of mortalities occurred on Day 3 for the exposed thiamine-replete salmon. The exposed thiamine deficient salmon presented with the greatest amount of mortalities on Day 6 and continued to have a steady rate of one mortality per day throughout the challenge (16 days).

Figure 5: Flavobacterium columnare was diagnosed through qPCR of gills and spleen, with the highest frequency of detection in the gills of the thiamine-replete Chinook salmon.

Conclusion

Thiamine deplete Chinook salmon fingerlings challenged with F. columnare presented significantly greater survival (p<0.0001) than the thiamine-replete Chinook salmon fingerlings.

Thiamine deficiency potentially led to a lack of an acute inflammatory response to the bacterium, resulting in higher thiamine mortality rate in fish with thiamine deficiency.

References


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