Toxicity testing of Atlantic salmon aquaculture chemotherapeutants on spot prawns and benthic invertebrates

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Introduction

Demand for protein sources is high in North America and rising globally. Aquaculture is one approach to meeting this demand. Intensive salmon farming practices result in periodic infestations with the naturally-occurring parasitic copepod *Lepeophtheirus salmonis*, commonly referred to as “sea lice.” To reduce productivity losses, chemical and physical treatments have been used to clear infestations.

To determine the level of risk aquaculture chemotherapeutic treatments pose to non-target marine annelids and crustaceans including spot prawns (*Pandalus platyceros*), king ragworms (*A. virens*), and amphipods (*E. estuarius*). The sub-chronic toxicity of the sea lice pesticides Slice® (active ingredient: 0.2% emamectin benzoate) and amphipods (*E. estuarius*) were adapted from Environment Canada, was spiked with Slice® (active ingredient:: 0.2% emamectin benzoate) spiked sediment 30 d-exposure. Nominal concentrations of 0, 1, 2, 5, 20, 100, 200, and 300 mg/kg Slice® with in SLICE®. Error bars indicate SE. Letters indicate evidence of a difference in growth rate in *A. virens* exposed to spotted SLICE® with in SLICE®. Error bars indicate SE. Evidence of a difference in growth rate was detected by way of KOLM, Tukey Kramer HSD pairwise comparison with effect threshold *P*<0.05.

Objective

To identify lethal and sub-lethal effects of the chemotherapeutic treatment Slice® (active ingredient: 0.2% emamectin benzoate) at environmentally relevant concentrations to non-target native marine annelids and crustaceans using spot prawns (*P. platyceros*), king ragworms (*A. virens*), and amphipods (*E. estuarius*).

Methods

Screened marine sediment was spiked with Slice® to achieve nominal concentrations representative of environmentally-relevant levels. Test organisms were exposed to spiked-sediments in aerated, water quality-monitored static systems for sub-chronic durations of 30-days (*E. estuarius* and *A. virens*) or 60-days (*P. platyceros*) using protocols adapted from Environment Canada,[1] ASTM,[2] and Park, 2013. Concentration-response was assessed using the endpoints of: mortality and behavioural responses. Mortality and growth was measured for all organisms. Daily burrowing/emergence and post-exposure re-burrowing rate were measured to determine *A. virens*. Molting incidence and post-exposure olfactory response were measured to determine *P. platyceros*.

Results

1: *A. virens* sub-lethal tests

Fig. 1: Mean day time sediment emergence rate of *A. virens* during SLICE® (0.2% emamectin benzoate) spiked sediment 30 d-exposure. Nominal concentrations of 0, 1, 2, 5, 20, 100, 200, and 300 mg/kg Slice® with in SLICE®. Letters indicate evidence of a difference in emergence rate by Tukey Kramer HSD pairwise comparison (P<0.05).

2: *A. virens* sub-lethal tests

FIG. 2 Mean time to re-burrow in clean sediment of *A. virens* post 30 d-SLICE® (0.2% emamectin benzoate) spiked sediment 30 d-exposure. Nominal concentrations (0, 1, 2, 5, 20, 100, 200, and 300 mg/kg Slice® with in SLICE®). Error bars indicate SE. Letters indicate evidence of a difference in re-burrow time by Tukey Kramer HSD pairwise comparison (P<0.05).

3: *E. estuarius* lethal tests

Fig. 3: Mean growth (g) final wet weight of *A. virens* exposed to SLICE® (0.2% emamectin benzoate) spiked sediment 30 d-exposure. Nominal concentrations of 0, 1, 2, 5, 20, 100, and 300 mg/kg Slice® with in SLICE®. Error bars represent SE. Evidence of a difference in growth rate was detected by way of KOLM, Tukey Kramer HSD pairwise comparison with effect threshold *P*<0.05.

4: *A. virens* lethal tests

FIG. 4: Mortality of *A. virens* in SLICE® (0.2% emamectin benzoate) spiked sediment 30 d-exposure. Nominal concentrations (0, 1, 2, 5, 20, 100, and 300 mg/kg) SLICE® with in SLICE® treated. Error bars indicate SE. Letters indicate evidence of a difference in mortality effects by Tukey Kramer HSD pairwise comparison with effect threshold *P*<0.05.

5: *E. estuarius* lethal tests

Fig. 5: Mortality of *E. estuarius* in SLICE® (0.2% emamectin benzoate) spiked sediment 30 d-exposure. Nominal concentrations of 0, 1, 2, 5, 14, and 28 mg/kg Slice® with in SLICE®. Error bars indicate SE. Letters indicate evidence of a difference in mortality effects by Tukey Kramer HSD pairwise comparison with effect threshold *P*<0.05.

6: *P. platyceros* sub-lethal tests

FIG. 6: *P. platyceros* lethal tests. Mortality of *P. platyceros* in SLICE® (0.2% emamectin benzoate) spiked sediment 30 d-exposure. Nominal concentrations of 0, 1, 2, 5, 14, and 28 mg/kg SLICE® with in SLICE®. Error bars represent SE. Letters indicate evidence of a difference in mortality effects by Tukey Kramer HSD pairwise comparison with effect threshold *P*<0.05.

Conclusions

- At high concentrations, Slice® was acutely lethal to polychaete *A. virens* and resulted in sub-lethal effects to daily emergence and post-exposure re-burrowing rate.
- Slice® caused mortality of *E. estuarius* at concentrations recorded near actively-treated aquaculture pains.
- Further study should be conducted on sub-lethal effects to benthic marine invertebrates including synergistic toxic effects of Slice® and ivermectin. Ivermectin is another avermectin under investigation for use in British Columbia aquaculture facilities.

Future Research

1. Table 1: Outline of completed, ongoing, and future chemotherapeutic sediment bioassays

Funding agency:

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References

5. Park, A. 2013. The biological effects of emamectin benzoate [SLICE®] on spot prawn (*Pandalus platyceros*).

Acknowledgements

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