Effect of peracetic acid on geosmin and 2-methylisoborneol levels in recirculating aquaculture system raising rainbow trout *Oncorhynchus mykiss*

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Introduction

Recirculating aquaculture system (RAS) enables reduction in water consumption and nutrient outlet[1], but unfortunately, has a tendency for the development of off-flavor compounds, mainly geosmin (GSM) and 2-methylisoborneol (MIB), in circulating water and fish flesh. Peracetic acid (PAA, CH_3COOH), is a strong disinfectant with antimicrobial activity and in aquaculture used to treat pathogens and improve water quality. The aim of this research was to study the effects of PAA addition on GSM and MIB concentrations in rainbow trout fillet and in circulating water.

Figure 1. RAS research system used to raise salmonids in central Finland (Photo Tapio Kiuru 14.9.2017).

Materials and Methods

An indoor RAS research system consisted of 8 separate units, each with a 500 L tank, separate water treatment and quality control systems (Fig. 1). Inlet water was led from an oligotrophic Lake Peurunka. There were 50 fish in each tank, weighting on average 130 ± 5 g and increasing in weight to 411 ± 43 g during the 13 weeks of experiment. PAA was applied to the pump sumps 0, 1, 2 or 4 times per week, 4 mL of PAA solution twice a day, consisting of 2.2 mg PAA L^{-1} per day. Concentrations of GSM and MIB in tank water and in rainbow trout fillet were analyzed to study the effect of PAA additions (Table 1).

Table 1. Methods and conditions for analysis of GSM and MIB concentrations in recirculating water and in rainbow trout fillet.

Treatment	Conditions
Sample	1 mL (water) /1 g (fish fillet) in 10 mL vial
HP-SPME	NaCl(aq), 60 °C water bath, 30 min.
GC-MS	Agilent 6890 series/5973 N Injector at 270 ºC, splitless mode Oven temperature 45 ºC for 3 min. 30 ºC min^{-1} to 300 ºC (total time 14.5 min) EI-MS, 230 ºC, 5 min. delay, ionizing voltage of 70 eV Base peak areas *m/z* 95, *m/z* 112 LOQ_{water} 2.1 ng L^{-1} (GSM), 0.8 ng L^{-1} (MIB) LOQ_{fish} 5.4 ng g^{-1} (GSM), 0.5 ng g^{-1} (MIB)
Column	Phenomenex Zebron ZB-5MSi capillary column (30 m x 0.25 mm x 0.25 µm)

Results and discussion

After 13 weeks, the levels in circulating water ranged between 1.9 and 49.7 ng L^{-1} (GSM) and between <LOD and 64 ng L^{-1} (MIB) (Fig. 2). The detected levels of this study are in similar range with previously reported[2,3] and decreasing after the PAA additions. Large differences between replicate tanks were observed, but as previously reported[2,4], there can be large differences between individual tanks.

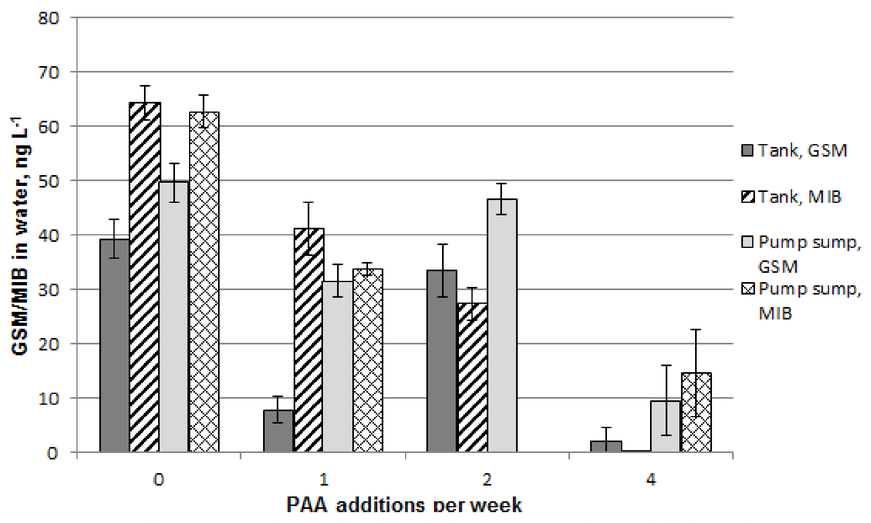

Figure 2. Levels of GSM and MIB in circulating water after addition of PAA 0, 1, 2 or 4 times per week, 2.2 mg L^{-1} day^{-1}.

The average concentrations in rainbow trout fillet ranged between <LOD and 11.9 ng g^{-1} for GSM and between <LOD and 11.4 ng g^{-1} for MIB (Fig. 3), and were in the same range with previous results[3]. The concentrations decreased with increasing additions of PAA per week, but in some cases with relatively large variations between measurements.

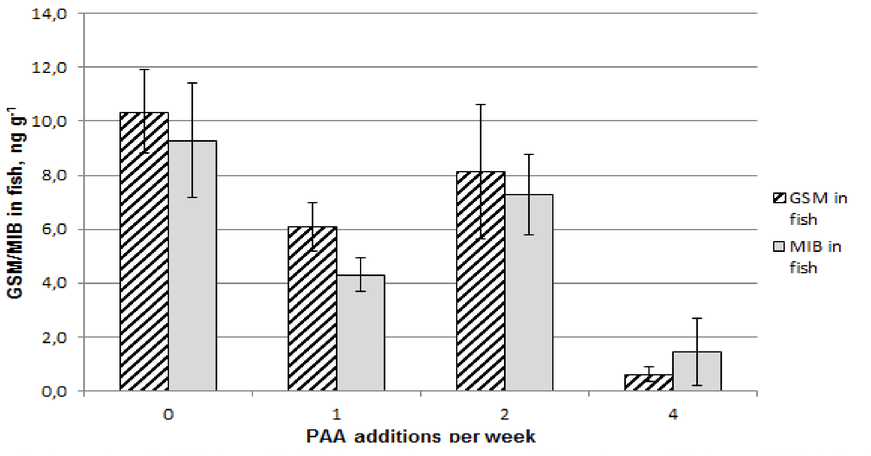

Figure 3. Levels of GSM and MIB in rainbow trout fillet after addition of PAA 0, 1, 2 or 4 times per week, 2.2 mg L^{-1} day^{-1}.

The fish developed an unusually thick layer of mucus and slime on the skin surface. The skin of fish is influenced by factors related to season, development stage, environmental conditions, stress, and disease[5]. Therefore, the PAA induced changes in the circulating water might have caused excess formation of mucus.

Conclusion

The results suggest that the highest rate of PAA additions (4 times per week) is temporarily able to decrease the levels of GSM and MIB, but inadequate to fully prevent their formation in the long run.

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