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Antimicrobial resistance in aquatic and fecal bacteria from a Recirculating Aquaculture System and comparison with human clinical isolates



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Introduction

Recirculating Aquaculture Systems (RAS) are novel food-producing environments

- Nearly fully re-use water
- Less effluents

But: lack of knowledge on **Antimicrobial Resistance (AMR)** in this environment (EFSA, 2021), and link with humans

Objectives:

- To identify the sources of AMR-bacteria in a RAS
- To assess persistence of AMR-bacteria in a RAS
- To compare with isolates from human infections



Materials and Methods

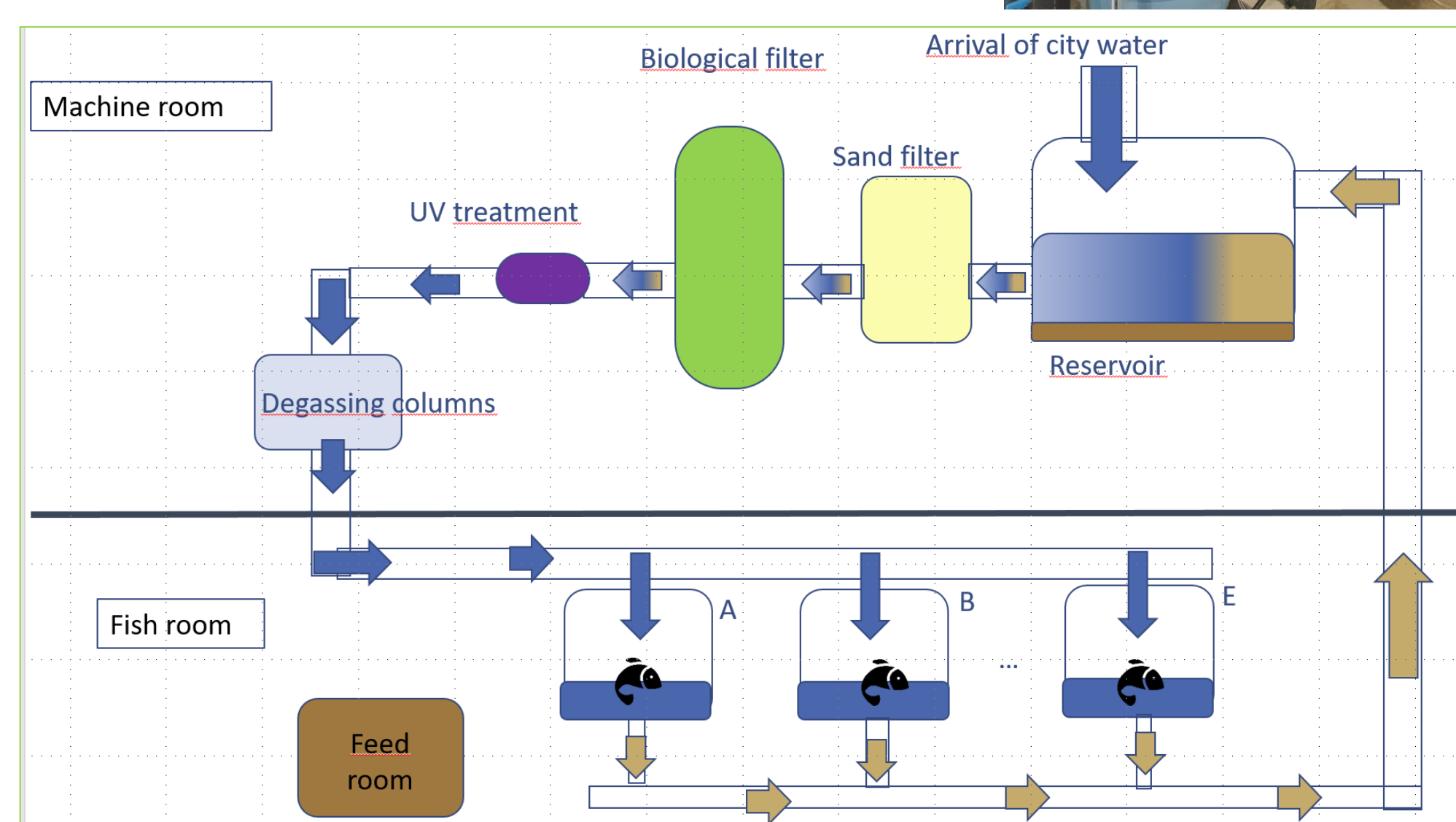
Longitudinal (Feb-June 2022), observational study

Experimental RAS raising rainbow trout at Oniris, Nantes (FR)

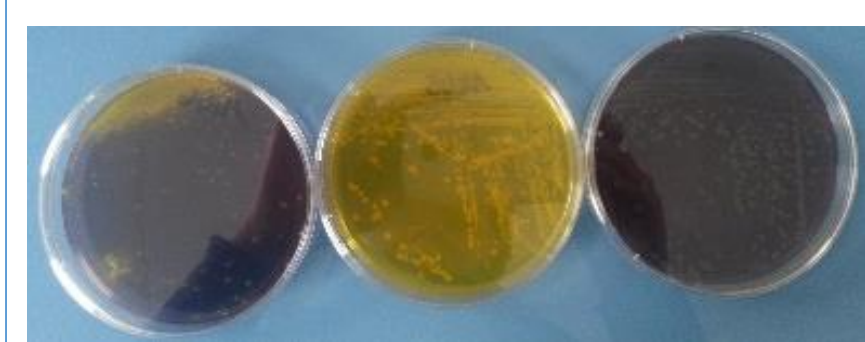
Use of **city water**, **commercial feed**, **purchased fry**

Monthly sampling of all compartments: **water, fish feces, sediment, biofilm, fish feed.**

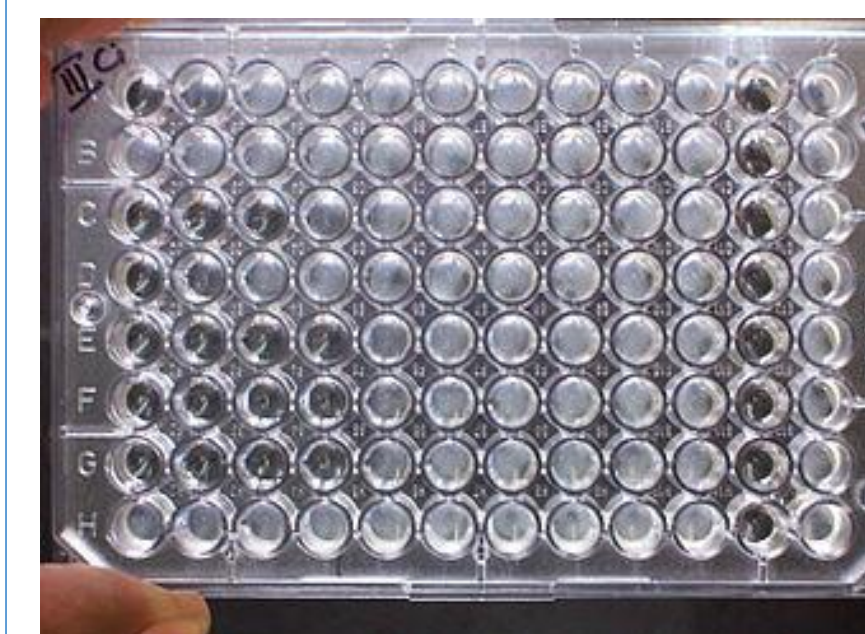
All water treatment steps and fish tanks. In total: **95 samples**



All samples were processed for the isolation of **fecal bacteria** (*Escherichia coli*, *Enterococcus* spp.) and **aquatic bacteria** (*Aeromonas* spp., *Pseudomonas* spp.). These bacteria are also considered **indicators of AMR from the environment.**



Isolates confirmed with MALDI-TOF and tested for AMR phenotype with the broth microdilution method (**Minimum Inhibitory Concentration**).



Human isolates retrieved from the collection of the **Nantes University Hospital** (CHU Nantes) and tested with the same method.

Epidemiological cut-off values were used to classify an isolate as susceptible or resistant, preferentially those values determined by the EUCAST.

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Results

Isolation rate of the selected bacteria per sample type:

Sample type (n)	<i>E. coli</i>	<i>Enterococcus</i> spp	<i>Aeromonas</i> spp.	<i>Pseudomonas</i> spp.
Water (33)	0	3 (9%)	26 (78%)	1 (3%)
Feces - tanks (23)	0	2 (9%)	20 (87%)	0
Feces - ind (7)	0	0	6 (86%)	0
Biofilm (23)	0	1 (4%)	20 (87%)	0
Sediment (5)	0	1 (20%)	5 (100%)	0
Feed (4)	0	3 (75%)	1 (25%)	0

Key results

- City water was negative for ALL bacteria tested.
- Aeromonas* were frequently isolated, but *E. coli* was absent and *Pseudomonas* were uncommon in the RAS.
- Fish feed was frequently positive for *Enterococcus* spp., including clinically important species like *E. faecium*. However, *E. faecium* was not detected inside the RAS.

AMR phenotypes in the RAS:

In *Aeromonas* spp: **resistance to Tetracycline** was the only « ubiquitous » phenotype.

MICs against CHL increased after a florfenicol treatment to the fish due to furunculosis, but this phenotype **did not persist.**

Enterococcus faecium from feed was susceptible to the antibiotics tested, except for DAP, TET, SYN and CHL. **Uncommon Enterococcus spp** were isolated from water, fish feces, sediment and biofilm (AMR not assessable).

In human infections:

Aeromonas spp.: For most antibiotics tested, distribution of MICs was similar to RAS isolates.

E. faecium were resistant to more antibiotics (9 out of 12)



Discussion

City water is not a source of the selected bacteria, but feed and fish can be vehicles of AMR-bacteria

AMR-*Enterococcus* from feed do not seem to persist in this environment

The similarity between the *Enterococcus* species and their AMR phenotypes found in RAS and in human infections is limited

Identification of *Aeromonas* species is needed to draw conclusions on the comparison of AMR phenotypes