PROJECT: OPTIMIZE
SYSTEM: RAS
PARTNER: Nofima
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Effects of light quality and intensity on fish performance and changes in intensity and spectral composition of light in RAS

HYPOTHESIS:

- Light intensity and spectral composition will affect growth, maturation, welfare and salt water tolerance of salmon post-smolts in RAS.
- Water quality will affect the attenuation and spectral composition of light in RAS.

DURATION: 2019-2021

FISH SIZE TESTED: 100-700 g Atlantic salmon postsmolt

SALINITY TESTED: Brackish water (12ppt)

HIGHLIGHTS:

- "Sun-like", full spectrum LED light did not yield any benefit compared to regular, white LED light. Red light at low intensity (0.25 µmol/m_2/s) did not affect performance, welfare or sexual maturation or development of salt tolerance in salmon post-smolts
- Increasing light intensity at the bottom of the tanks from 0.25 µmol/m_2/s (low intensity) to 1.94 µmol/m_2/s (high intensity) did not yield any benefits for growth performance (Measurement depth ~0.8 m; Surface light intensity 10.1 µmol/m_2/s [1.6 W/m2] and 1.3 µmol/m_2/s [0.2 W/m_2] for high intensity and low intensity treatments, respectively)
- Water quality in RAS had a strong effect on light intensity and spectral composition of light (Figure1)
    - We calculated that only 0.1 % of the surface light from white/"sun-like" LEDs would remain a depth of 3 m. This is 16x less light than with the relatively clean water at the start of the experiment (Turbidity: ~1.7 NTU vs. ~6.7 NTU). To provide sufficient light to maintain intensities above maturation threshold, this would correspond to an increase from 0.8 to 12 W/m_2 to offset the effect of "dirty" water
    - Contrary to a higher transmission of blue light in clean, oceanic water, the absorbance of blue light was 60% higher than green or red light in RAS. In RAS, the transmission of blue light at a depth of 3 m would be 126 and 155 lower than green and red light, respectively

RECOMMENDATIONS:

- Results suggest that light intensity is more important than spectral composition for Atlantic salmon postsmolt performance and maturation in RAS.
- Untreated RAS water creates a steep light gradient in the tank. Surface illumination in deep, commercial tanks may not be sufficient to maintain light intensities

above thresholds relevant for vision or maturation (0.037 µmol/m_2/s and 0.056 µmol/m_2/s, respectively; Bui et al., 2013; Leclercq et al., 2011).
- Lights optimized for "ocean-use" is less effective in RAS, due to lower penetration of blue light in RAS (or even in flow-through systems rich in humic acids!).
- If light intensity is a limiting factor for salmon production in deep tanks, surface light can be supplemented by underwater light for more local effect and further on by improving water clarity of RAS water using advanced water treatment (skimmers, ozone, etc.).

The factsheet is not yet ready for implementation. More testing under commercial conditions is needed.

READ MORE:

D6.1/LIGHTQUAL/2021: Report summarizing key findings from LIGHTQUAL experiment

D6.1/OPTIMIZE/2021: Preliminary data analysis of incubation experiments concluded

ADDITIONAL INFO:

- Follow-up trials with in-vitro incubations and water samples from RAS confirmed that absorbance characteristics of dissolved organic matter in RAS water are similar to organic matter present in natural waters.
- Qualitative absorbance properties of dissolved organic matter in BOD assays with sludge seems to match dissolved organic matter in RAS.
- Particles seem to be main driver in absorbance in visible spectrum (400- 700 nm), whereas dissolved fraction seems to be main driver in UV-range (254 nm).
- Results suggest that dissolved organic matter has a relatively higher effect on the disparity in absorbance between blue, green and red light than particulate organic matter.

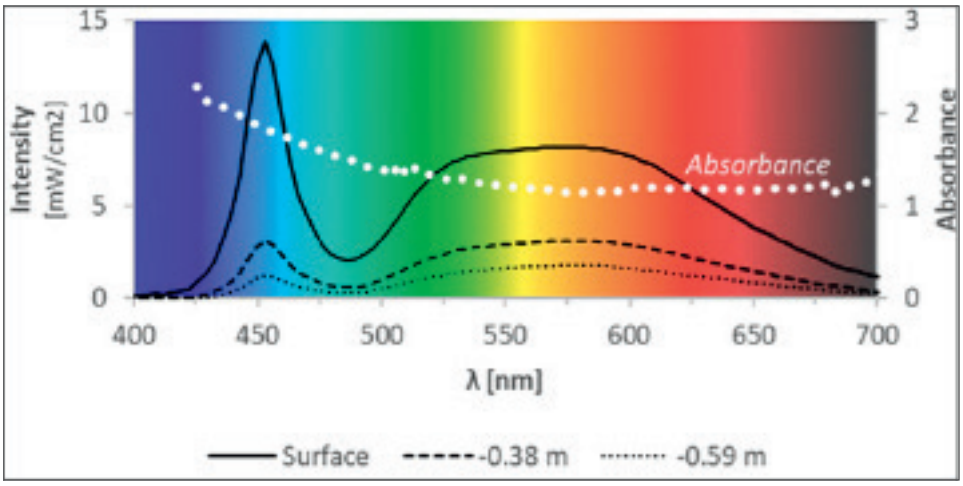

Figure 1: Example for changes in spectral composition of white LED light, absorbance was calculated for each wavelength. Black lines represent light intensities at different water depths (surface, 0.38 m, 0.59 m) and the white dotted line represents absorbance. Note how drastically the relation of the peak height at 450 and 550-600 nm changes, and how the absorbance increases in the blue spectrum from 400-550 nm.