



Using Optical Methods to Study the Effect of Detergents on *Elodea canadensis*

O. A. Trutko¹, E. S. Vasilenko², L. P. Timchenko², E. V. Timchenko¹

¹ Samara National Research University, Samara, Russia

² MBFI Lyceum "Technical" named after S.P. Korolev, Samara, Russia



Introduction

Detergents are among the most common pollutants entering water bodies with domestic wastewater. They negatively affect aquatic plants, primarily disrupting photosynthetic processes. Optical methods allow non-invasive monitoring of these changes.

Materials and Methods

The aquatic macrophyte *Elodea canadensis* was grown in distilled water in three 1-liter containers for three months.



The plants were divided into 3 groups:

Group 1 – control (without detergents)

Group 2 – with the addition of dishwasher powder "Clean Fresh" (1 mg/L)

Group 3 – with the addition of dishwashing liquid "Fairy" (1 mL/L)

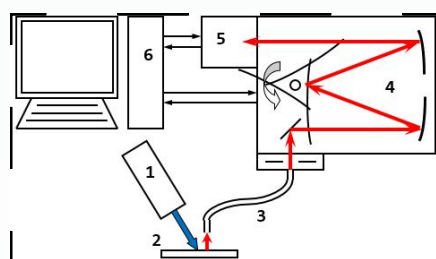


Figure 1 – **Fluorescence spectroscopy**: 1 – excitation source (488 nm LED), 2 – sample, 3 – receiving optical fiber, 4 – Shamrock SR-303i spectrometer, 5 – ANDOR DV-420A-OE digital camera, 6 – computer.

Figure 2 – **Laser confocal fluorescence microscopy**: 1 – halogen lamp (visible light source), 2 – collimator, 3 – sample, 4 – objective, 5 – rotating mirror, 6 – confocal scanning unit, 7 – filter block, 8 – camera, 9 – computer, 10 – laser block.

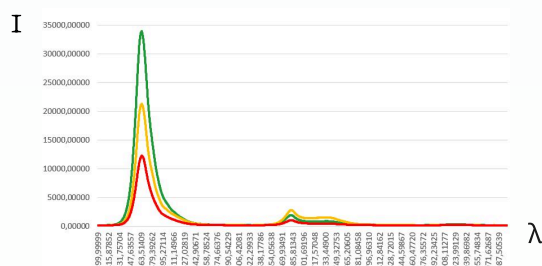
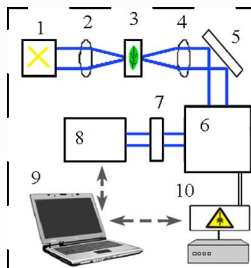


Figure 3 – Fluorescence intensity spectra on day 63 of the experiment: green line – group 1 (control), yellow line – group 2 (Clean Fresh) red line – group 3 (Fairy)

Results

An optical coefficient reflecting the chlorophyll concentration in the samples was introduced [1]:

$$K = I_{738} / I_{685}$$

where:

I_{738} – fluorescence intensity at 738 nm (corresponding to cellulose absorption);

I_{685} – fluorescence intensity at 685 nm (chlorophyll absorption maximum).

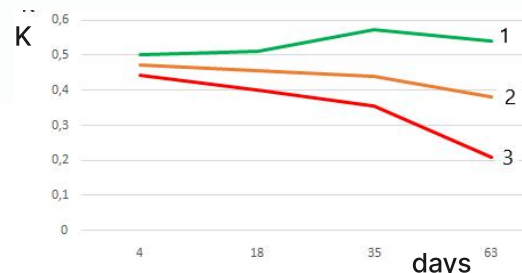


Figure 4 – Optical coefficient versus time: green line – group 1 (control), yellow line – group 2 (Clean Fresh), red line – group 3 (Fairy)

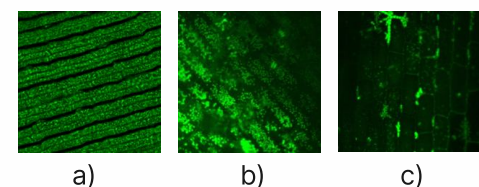


Figure 5 – Micrographs of samples on day 63 of the experiment: a) group 1 (control), b) group 2 (Clean Fresh), c) group 3 (Fairy)

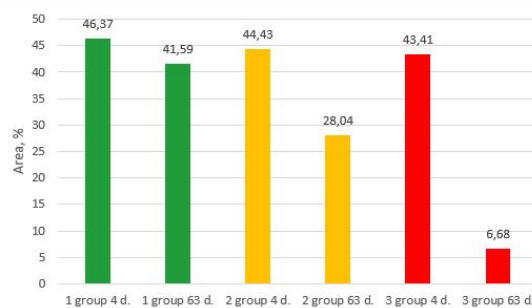


Figure 6 – Percentage of area occupied by chloroplasts at the beginning and end of the experiment: green line – group 1 (control), yellow line – group 2 (Clean Fresh), red line – group 3 (Fairy)

The percentage of the micrograph area occupied by chloroplasts was calculated using the ImageJ program on days 4 and 63 of the experiment.

Conclusion

The experimental studies using the optical methods revealed that both detergents negatively impacted the chlorophyll concentration of *Elodea canadensis*, but the degree of toxicity varied. To assess the toxicity of the studied detergents on *Elodea*, an optical coefficient was introduced. This showed that Fairy dishwashing detergent had a more pronounced toxic effect on aquatic plants, as evidenced by a 2-fold decrease in the optical coefficient (at the end of the experiments) compared to Clean Fresh detergent.

Microscopic analysis confirmed the results obtained using fluorescence analysis.

Thus, the combination of methods (fluorescence spectroscopy and confocal microscopy) is an effective tool for monitoring the condition of aquatic plants exposed to detergents..