



## Toxicity evolution of alum-coagulated municipal wastewater to sea urchin embryogenesis and fertilization

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### ABSTRACT

The alum-based coagulation process is a worldwide treatment method in industrial and municipal wastewater (MW) management. In the present study, alum-coagulation was performed on wastewater from the MW plant located south of Naples, Italy, to evaluate any negative impact of MW on marine biota by means of sea urchin bioassays. A series of Jar test experiments (100 rpm for 1 min, 30 rpm for 20 min, and 30 min for settling) was performed using 150 and 450 mg/L of alum concentrations at pH ranging from 5 to 7 and room temperature ( $20^{\circ} \pm 2^{\circ}\text{C}$ ). Raw and alum-coagulated wastewater samples were analyzed for their COD and TSS, and residual aluminum (RA) concentrations. Toxicity testing of samples (diluted to 1%) by *Sphaerechinus granularis* sea urchin bioassays (collected in Naples bay) was evaluated to meet the following specifications: (a) acute and/or developmental toxicity, (b) changes in fertilization success, and (c) cytogenetic abnormalities. The results provided the following evidences: (i) the coagulation process at a 150 mg/L alum level in the SG plant was sufficient to meet the discharge standards; (ii) RA was found significantly related to alum dose used in coagulation process and raw wastewater alum concentration; (iii) sea urchin bioassays provided evidence for both embryo toxicity in raw wastewater to a lesser extent, and in alum-coagulated Jar test supernatants, at elevated extent, at a 1% concentration; and (iv) no statistically significant spermiotoxic or cytogenetic effect was observed. Altogether, the results highlighted the influence of wastewater characteristics on developmental toxicity, such as pH-related Al(III) speciation and alum complex formation in wastewater.

*Keywords:* Toxicity; Coagulation; Alum; Residual aluminum; Municipal wastewater; Sea urchins

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