Ecotoxicological assessment of two corrosion inhibitor surfactants (Silicon-Q-22 and Poly-Q-47) using zebrafish embryo model

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Health and Biomedical Sciences

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ABSTRACT

In this study, zebrafish (Danio rerio) embryos was served as a model for marine fauna to determine if there is any potential of organ-specific toxicity (neuromuscular, hepatic, cytotoxic, and cardiac) caused by Silicone-Q-22 and Ploy-Q-47. as both surfactants are considered eco-friendly corrosion inhibitors. The calculated LC50 of Silicon-Q-22 and Poly-Q-47 was 22.36 and 8.28 mg/L, respectively. At NOEC both surfactants had resulted in teratogenic defects and cardiotoxicity, but only poly Q-47 resulted in neurotoxicity

INTRODUCTION

Surfactant research is a rapidly developing field due to their booming applications in many important practical and fundamental industries like petroleum oil recovery, water, and environmental pollutions, and most importantly, corrosion inhibition. Silicon-Q-22 and Poly-Q-47 surfactants are very efficient "green" corrosion inhibitors. To the best of our knowledge, no previous studies were conducted to report the safety of both surfactants on the environment with respect to the aquatic organisms.

METHADOLOGY

The potential organ-specific (cardiac, hepatic, and neuromuscular) toxicity of Silicon-Q-22 and Poly-Q-47 using the zebrafish embryo model. This includes (i) mortality/survival rate assay to determine the median lethal concentration (LC50); (ii) teratogenicity assay to evaluate the no observed effect concentration (NOEC); (iii) organ-specific toxicity assay including cardiotoxicity analysis, neurotoxicity (locomotion assay), hepatoxicity (liver size and yolk retention using ORO staining), hematopoietic toxicity (using o-dianisidine stain), and cellular stress/apoptotic cells detection (using acridine orange).

RESULTS

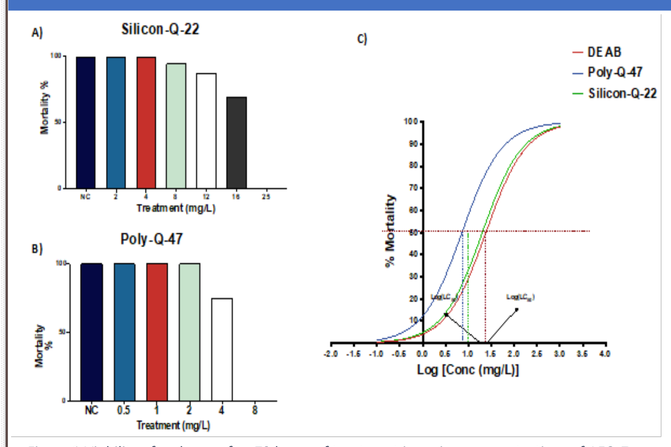

*Figure 1 Viability of embryos after 72 hours of treatment in various concentrations of AEO-7 compared to positive and negative controls. (A) mortality rate of treated embryos with silicon Q-22 at 96 hpf. (B) mortality rate of treated embryos with poly Q-47 at 96 hpf. (C) Graph demonstrating the LC50 of silicon Q-22 and poly Q-47 in compared to the DEAB (PC). * = p < 0.05, ** = p < 0.01, *** = p <0.001*

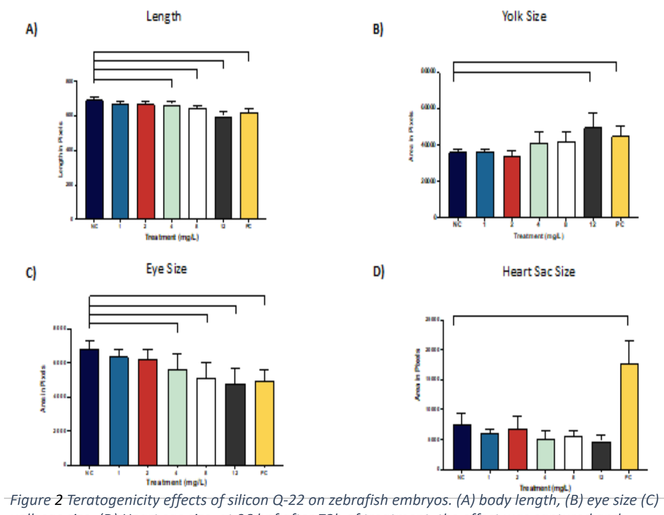

Figure 2 Teratogenicity effects of silicon Q-22 on zebrafish embryos. (A) body length, (B) eye size (C) yolk sac size, (D) Heart sac size. at 96 hpf after 72h of treatment, the effect was captured and analyzed using two software's, HCImage and ImageJ version 1.52a respectively. n = 6-8.

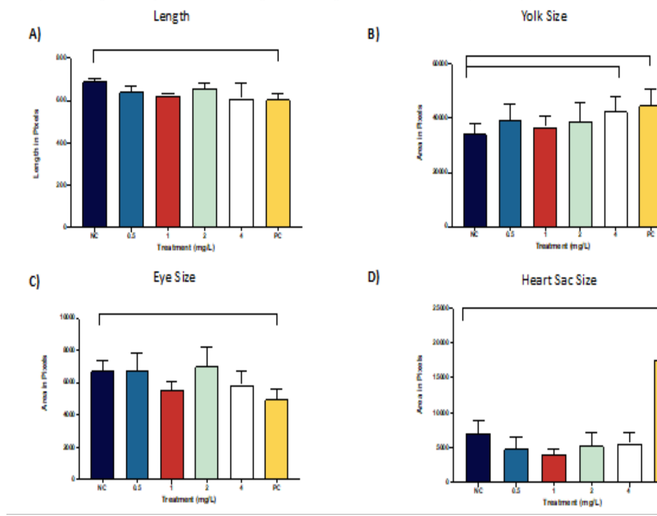

Figure 3 Teratogenicity effects of Poly-Q-47 on zebrafish embryos. (A) length of the body, (B) eye size (C) yolk size, (D) Heart sac size. at 96 hpf after 72h of treatment, the effect was captured and analyzed using two software's, HCImage and ImageJ respectively. n = 6-8

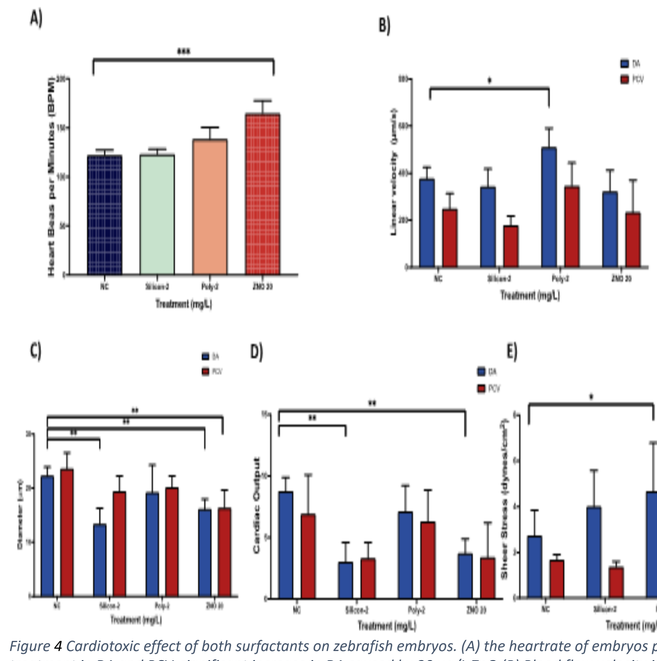

Figure 4 Cardiotoxic effect of both surfactants on zebrafish embryos. (A) the heartrate of embryos post-treatment in DA and PCV, significant increase in DA caused by 20 µg/L ZnO (B) Blood flow velocity in DA and PCV. (C) The vessel diameter, significant decline seen in Silicon-Q-22 in DA and ZnO in DA and PCV. (D) Cardiac output, significant drop in the values was seen in DA caused by Silicon-Q-22 and ZnO. (E) calculated shear stress. n =6.

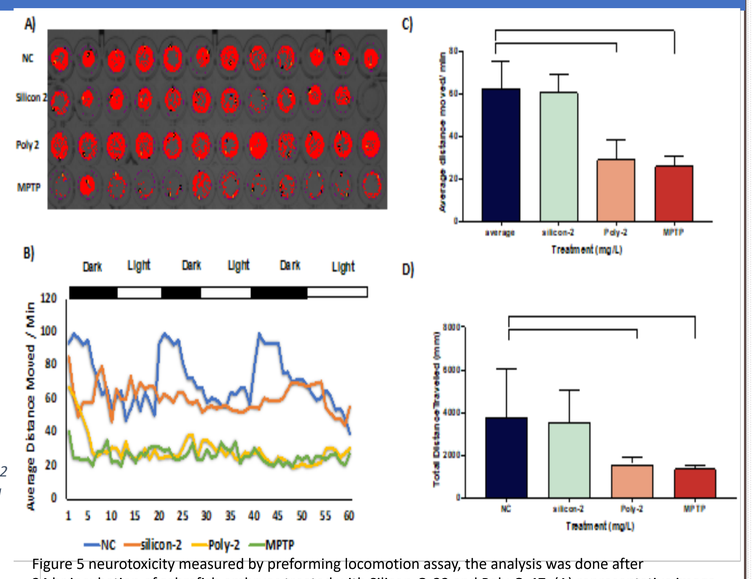

Figure 5 neurotoxicity measured by preforming locomotion assay, the analysis was done after 24 hr incubation of zebrafish embryos treated with Silicon-Q-22 and Poly-Q-47. (A) representative image for the tracking of the embryos in the plate under the DanioVision device. (B) Average distance moved per minute in response to the dark and light stimulus. (C) The average distance moved of embryos per minute. (D) the total distance moved in 60 min.

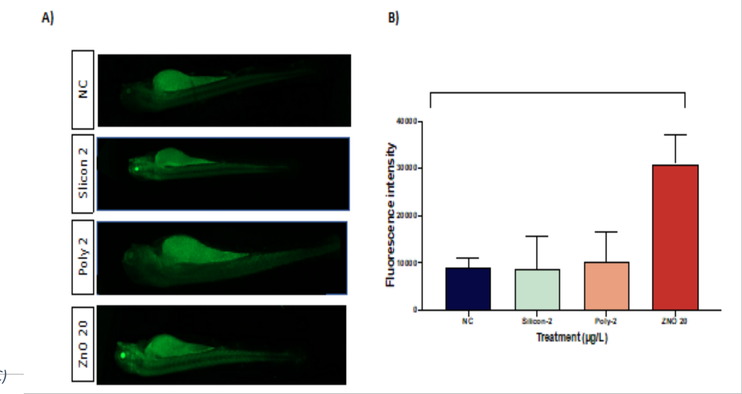

Figure 6 apoptosis detection using Acridine Orange. (A) images of stained zebrafish embryos with AO at 96 hpf (100 uL of 5ug/ml of AO after 72 hours of treatment, green, fluorescent cells at 100x magnification represent apoptotic cells. (B) AO fluorescence intensity, untreated embryos (NC) showing almost no apoptosis. Both surfactants did not induce a significant apoptosis level. Significant apoptosis was detected in embryos treated with ZnO 20

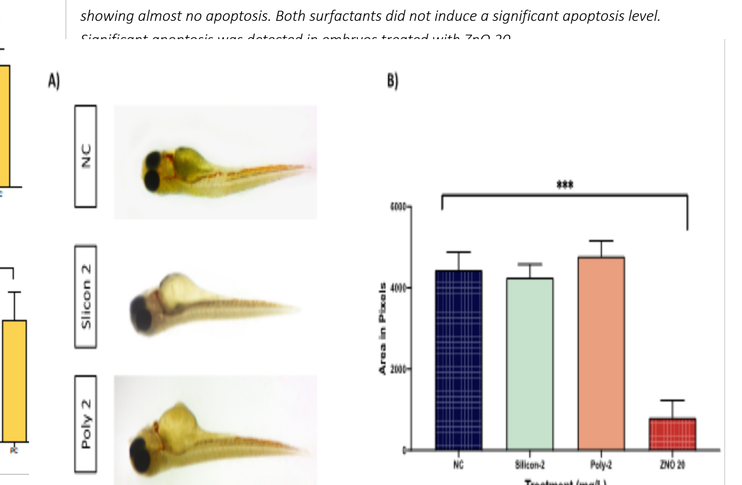

Figure 7 The effect of Silicon-Q-22 and Poly-Q-47 on hemoglobin levels in embryos. (A) Images of embryos with O-dianisidine stain, treated with the NOEC of silicon Q-22, poly Q-47, negative control, and 20 µg/L ZnO. (B) the total hemoglobin level detected using o-dianisidine satin. n =6.

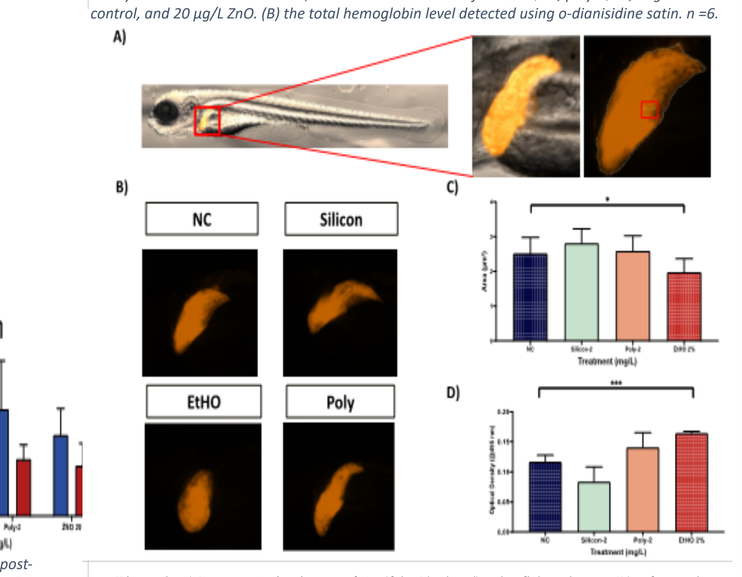

Figure 8. A) Representative image of Tg (fabp10: dsred) zebrafish embryos. B) After each treatment, images of the RFP liver region were taken. C) Quantification of RFP liver region (mm2) for all studied compounds and controls. D) Oil red O staining of lipids and neutral triglycerides in zebrafish embryos. (A) optical density analysis of oil red O. n =30.

CONCLOSION

The results concludes that, according to the Acute Toxicity Rating Scale provided by the USFWS, Silicon-Q-22 was described as "Slightly toxic" and Poly-Q-47 as "Moderately Toxic". Thus, we believe our results add valuable information to the potential toxicity of both surfactants to ensure their safety before implementation into the environment (especially as anti-corrosive).

ACKNOWLEGMENTS

I want to thank Dr. Gheyath Nasrallah for his supervision and monitoring this project. Also, special thank for Ms. Nadin Younes the research assistant for her effort and help throughout this project. And Ms. Enas Al-absi for zebrafish embryos culture.

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