

Is crab exoskeleton a repository of the divalent heavy metal cadmium?



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ABSTRACT

The post-ecdysial mineralization in crustaceans involves deposition of carbonate salts, such as calcium carbonate, to the organic matrix in the new exoskeleton. Cadmium is a toxic, non-essential metal frequently found in tissues of aquatic crustaceans. In spite of the similarity between cadmium and calcium ions, no study has previously been carried out to investigate whether the exoskeleton is a repository of cadmium. The purpose of this project was to determine whether cadmium is incorporated into the new shell during the post-ecdysial mineralization using the blue crab, *Callinectes sapidus* as the model crustacean. It was hypothesized that the injected cadmium would be deposited into the shell by calcium transporters in the epidermis during the mineralization process because of the resemblance between cadmium and calcium ions. To test this, soft shell blue crabs were injected with cadmium chloride, and cadmium content in the exoskeleton was quantified using ICP-OES. Cadmium content in the hepatopancreas, blood, gills and muscles will also be analyzed. As carbonic anhydrase is an important enzyme in the mineralization process, its activity levels were also analyzed for both groups. The initial findings of this study have suggested that during the mineralization process, blue crabs can incorporate cadmium into their shells as they would calcium. The presence of cadmium in control crabs and the amplification of cadmium content in treated crabs suggests that crab shells can be used as biomarkers for cadmium pollution.

OBJECTIVE

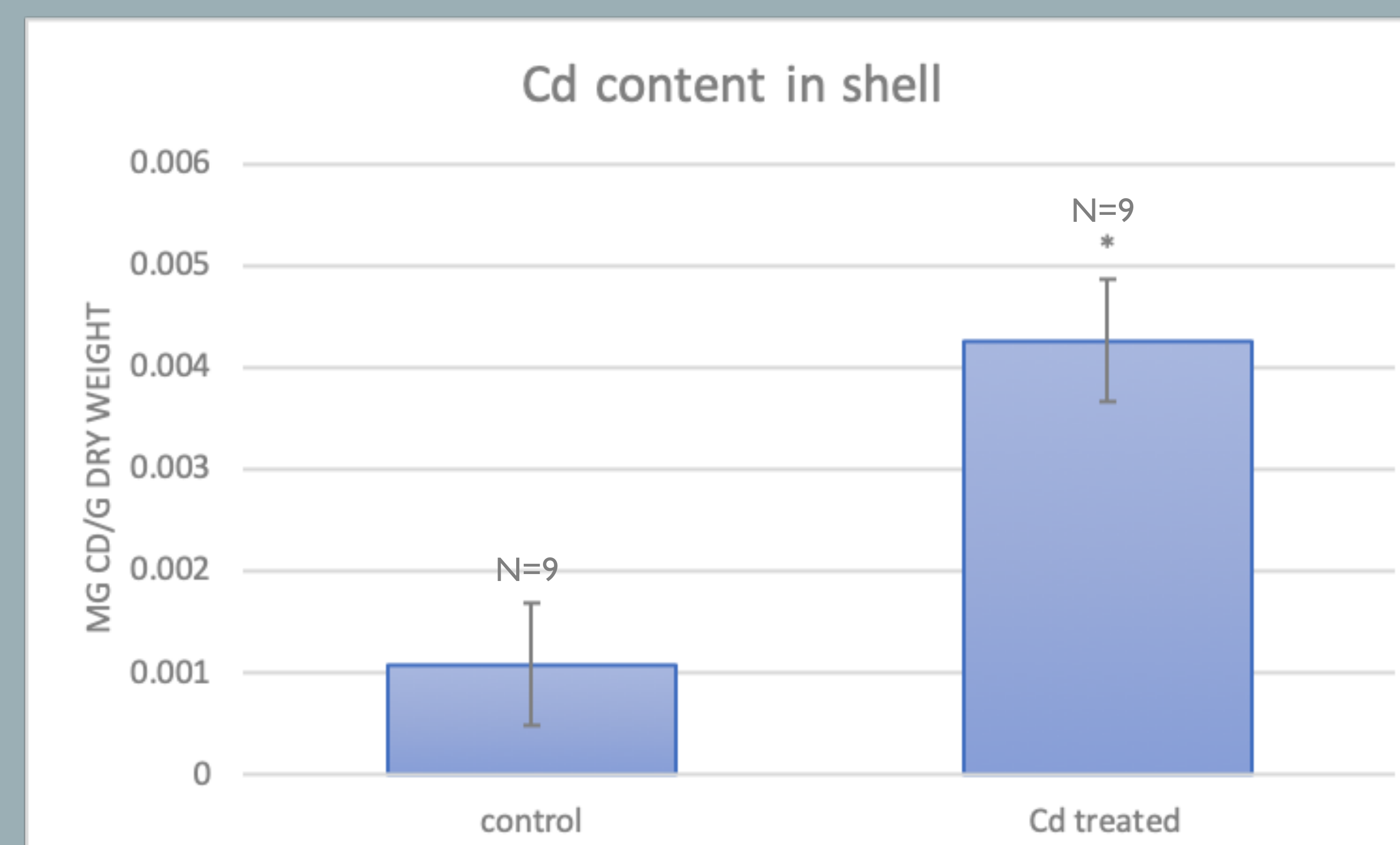
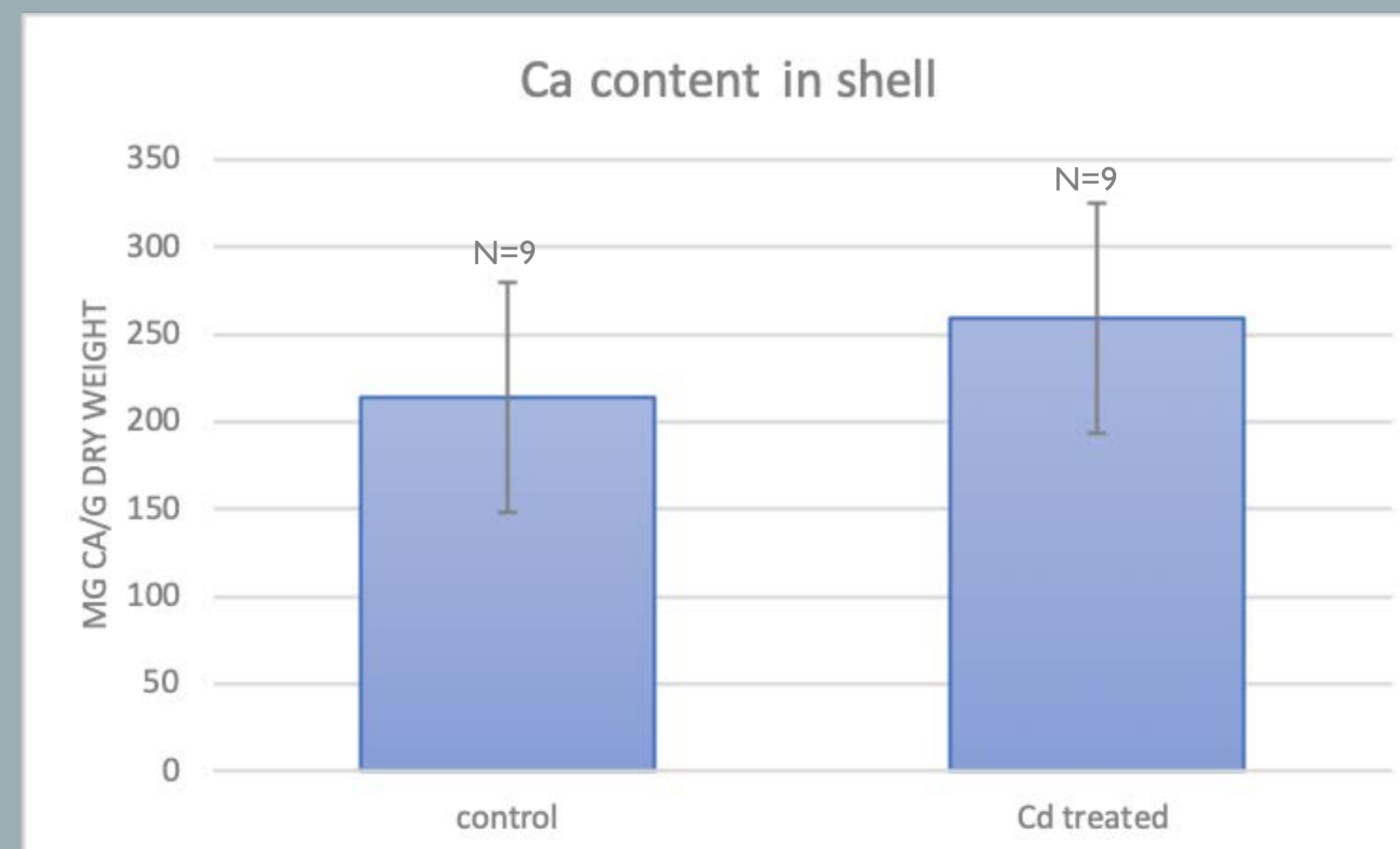
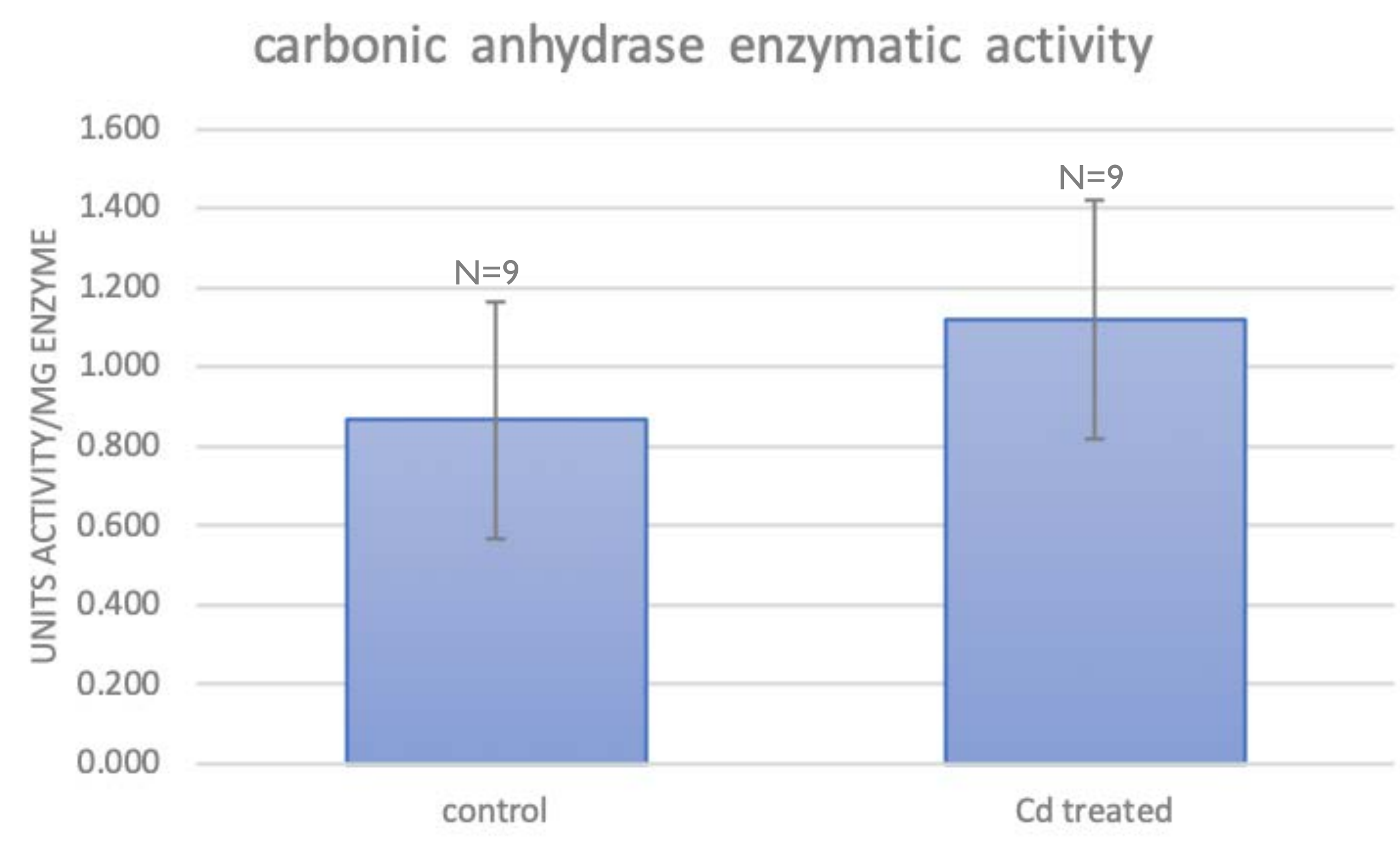
The objective of this research project was to determine if the shell of the model crustacean, *Callinectes sapidus*, is a repository for cadmium as it is for calcium by the delivery of cadmium ions using calcium transporters during the post-ecdysial mineralization process. It also aimed to determine if cadmium in crustacean exoskeleton can be used as a biomarker for aquatic cadmium pollution.

METHODOLOGY

- Buster crabs were collected and placed into tanks of artificial seawater adjusted to a salinity of 10 ppt and fed shrimp twice a week.
- Two injection solutions were prepared, one containing only crab saline for control crabs, and the other containing cadmium as well as saline. Crabs were injected 1 and 3 days postmolt and sacrificed on day 4 so tissue and blood samples could be collected and the carapace could be allowed to air dry.
- Carbonic anhydrase activity in the skin was quantified according to the Worthington Biochemical Co. protocol.
- Tissue and exoskeletal samples were then be dried and weighed. Metal content was analyzed using an ICP-OES spectrometer. Cadmium and calcium content was measured in the shell samples, and the same will later be done for all other tissue samples.
- Significance of the difference in cadmium and calcium content was analyzed using a student's T-test.



Figure 1: ICP-OES was used to measure metal content.



RESULTS AND DISCUSSION

- The results of the carbonic anhydrase assay have suggested that cadmium treatment does not affect the enzyme's level of activity.
- There was not a significant difference in calcium content in the shell between the two groups. However, the cadmium treated crabs contained significantly more cadmium in the shell.
- This is the first direct evidence that Cd is incorporated into the exoskeleton during post-ecdysial mineralization phase.
- **The presence of cadmium in control crabs and the increase of cadmium content in treated crabs suggests that crab shells can be used as biomarkers for cadmium pollution.**
- Follow-up studies can be carried out to establish which epidermal calcium transporters are responsible for the delivery of cadmium to the exoskeleton.



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