

Uptake of Cadmium Adsorbed on Particulates by Gills of Goldfish (*Carassius Auratus*)*

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Goldfish (*Carassius auratus*) were exposed to mixtures of constant dissolved cadmium (0.01 mg/l) and cadmium adsorbed on gibbsite particles at varied concentrations of 0, 0.025, 0.050, 0.075, and 0.100 mg/l. The gills of the fish were excised after 5-day exposure and both cadmium and aluminum in the gills were measured. The gills were also examined with a light microscope for surface adhering of the particles after the exposure.

The results showed that the concentration of cadmium in the gills increased with increased concentration of particulate cadmium while the dissolved cadmium remained constant. This agrees with the results of previous studies using copper and lead (Tao et al., 1999a, 1999b).

It is proposed that the gibbsite particles passed through the narrow channels could adhere on the surface of the mucus layer. The rest of the particles on the gill surface give time for cadmium desorption within the relative acidic condition of the gill microenvironment. Since mucus likely concentrates metals near gill surfaces in close proximity to membrane transport sites (Kirchner, 1987), the desorbed cadmium can readily translocate into the mucus layer and consequently into the epithelial cell. The gibbsite particles would not stay on the gill surface forever and will leave the gill together with the sloughed mucus.

The first step of the proposed translocation of the particulate cadmium is the adhering of the gibbsite particles onto the mucus covering the gill surface which was confirmed by photos taken of squashed fish gills specimens under 400 × microscopy. It can be clearly seen that the crystals of gibbsite rested on the surface of the gill filaments which are usually covered by a layer of mucus. In a similar study on the bioavailability of particulate lead to fish gills, Tao and colleagues observed adhering of particles on the fish gills using thin pieces of gill section cutting (Tao et al., 1999b).

The accumulation of aluminum in the gills exposed to the particulate cadmium was observed as well. With the presence of gibbsite in the bulk solution, the aluminum contents in the gills were significantly higher than that exposed to only dissolved cadmium. However, no increase trend of aluminum accumulation was observed with increase in gibbsite content in the bulk solution. Although the gill samples were rinsed in distilled water after being excised, it is no guarantee that all particles adhering to the gill surface, specially those within the fine structure of the gills, were removed. Even though gibbsite is generally insoluble in water under experimental conditions, some dissolution of trace amounts of aluminum from the particles could not be entirely ruled out. As such, it is not possible to tell whether or not the aluminum detected in the gill samples originated from dissolved species in the gill tissue or particles stuck on the surface of the gills or particles phagocytized by the gills.

To distinguish the origins of the elevated aluminum in the gills, the aluminum to cadmium ratios in the gills were calculated and compared to the ratio in the bulk solution. The exposed particulate cadmium in the water is proportional to the contents of gibbsite in the water. If the accumulation of aluminum in the gills was mainly due to either phagocytose of gibbsite or adhering of the particles on the gill surface, the Cd/Al ratio in the gills would be more or less the same as that in the water. This ratio in the water ranged from 0.0031 to 0.0040 (w/w) in the particulate cadmium exposure experiment, while the measured Cd/Al ratio in the gills varied from 0.0369 to 0.212 (w/w), indicating the key mechanism is the stripping, or desorption, of cadmium from the gibbsite particles which temporarily adhered to the gill surface mucus.

References

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