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Methylmercury Quantification Using A DNA-based Optical Sensor Coupled With a Portable Fluorometer

Methylmercury, an organic formation of mercury, occurs from the microbial activity mostly in upper sedimentary layers of sea bottoms. It is taken up rapidly by the food web, with greater accumulation in higher trophic levels. Moreover, methylmercury is effectively absorbed (more than 90%) in the gastrointestinal tract of humans, whereas inorganic mercury is poorly absorbed. Eating seafoods especially fish and shellfish that have high levels of methylmercury in their tissues can directly affect to the consumers and infants when their mothers eat fish and shellfish that contain methylmercury. Possible symptoms of methylmercury poisoning such as loss of peripheral vision, impairment of speech, hearing, and walking. Moreover, in children, methylmercury have impacts to their cognitive thinking, memory, attention, language, fine motor skills, and visual spatial skills. Therefore, methylmercury quantification is important. To quantify the concentration of methylmercury accumulated in fish or shellfish onsite, herein, we develop a DNA-based optical sensor coupled with a portable fluorometer. The sensor consists of two parts. The first part involves methylmercury binding in which the presence of methyl mercury results in a liberation of single stranded DNA, called the 'catalyst'. In the second part, the 'catalyst'catalyzed a formation of duplex DNA from two DNA hairpins, that would have not hybridized in the absence of the 'catalyst'. By doubly labeling one of the DNA hairpins with a fluorescent dye and a quencher, we are able to report the formation of duplex DNA and the presence of methylmercury. Under the optimal sensing conditions, the sensor provided a good sensor performance to the standard methylmercury both under a commercial fluorometer and our laboratory-built portable fluorescence detector. Therefore, the developed sensing system has a potential for onsite methylmercury detection.

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