

Predicting the Impact of Foods on Mercury Bioavailability

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ABSTRACT

The effects of phytochemical-rich foods or food components on bioaccessibility of mercury from fish were investigated by using an *in vitro* digestion coupled with a Caco-2 cell model to predict absorption. Mercury uptake by Caco-2 cells (TC7 clone) from the aqueous phase digesta was measured following a 6 h incubation at 37 °C. Black tea powder (31 and 62.5 mg) reduced mercury uptake by 90% compared to green tea. Soy protein powder (100 mg) and sodium copper chlorophyllin powder (1-25 mg) both decreased cellular mercury uptake; whereas, grapefruit juice (0.5-10 mL) had no effect on cellular mercury uptake. Wheat bran reduced cellular mercury uptake greater than oat bran; however, psyllium had no significant effect on mercury uptake. Our study supports an effect of foods and phytochemicals on mercury bioavailability.

METHODS

food component & King mackerel (1 ppm Hg)

in vitro digestion

aqueous fraction (1 mL) cell medium (3 mL)

Uptake by Caco-2 cells, at 37°C, 6 hr



harvest cells

total Hg analysis

- green and black tea
- soy isolate protein
- wheat bran
- oat bran
- grapefruit juice
- sodium copper chlorophyllin
- psyllium
- DMPS

- Gastric: pepsin (porcine), pH 2, 37°C, 1 h
- Small intestine: bile/pancreatin/lipase (porcine), pH 7, 37°C, 2 h
- Digesta = Aqueous phase (AQ) + precipitate
- Test media = filtered AQ + DMEM cell medium

INTRODUCTION

Fish is a source of high-quality protein, vitamin D, selenium, omega-3 fatty acids, and other nutrients. Fish consumption, however, has also been identified as the main source of methylmercury exposure in humans (Marsh *et al.*, 1995; NAS, 2000). In order to reduce the body burden of methylmercury, chelating agents such as 2, 3-dimercapto-1-propane sulfonate (DMPS) have been used (Aposhian *et al.*, 1992; NAS, 2000). However, the use of a chelating agents to treat chronic methylmercury exposure by fish-eating populations is not practical. Alternatively, many studies have suggested that dietary factors can reduce methylmercury exposure to humans (Chapman and Chan, 2000). Bioaccessibility is defined as the amount of a compound released from an ingested food matrix into gastrointestinal tract juice and which is available for absorption by the intestinal mucosa (Garrett *et al.*, 1999; Versantvoort *et al.*, 2005). Caco-2 cells have been used to predict the uptake of nutrients, chemicals, toxins, and drugs in the human intestine (Aduayom *et al.*, 2003). When coupled with a simulated gastrointestinal digestion, a rapid and inexpensive approach to estimate bioavailability of chemical toxins is possible (Versantvoort *et al.*, 2005).

RESULTS

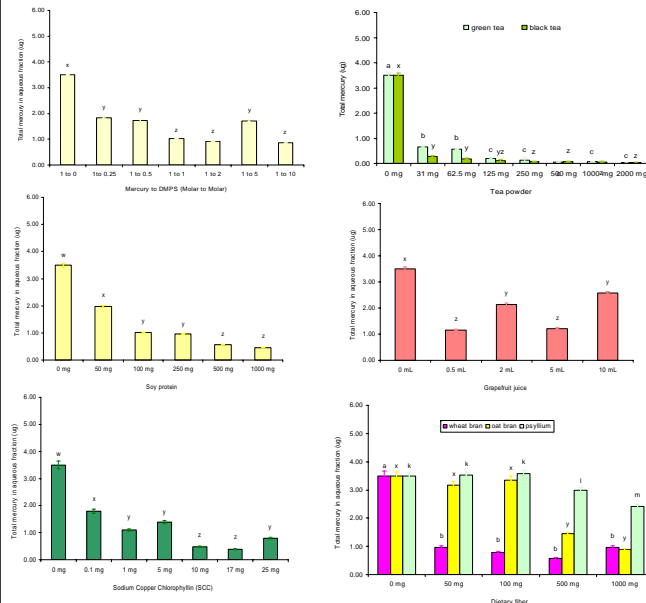


Figure 1. Impact of phytochemical-rich foods on mercury bioaccessibility (mercury in aqueous phase) following *in vitro* digestion

RESULTS

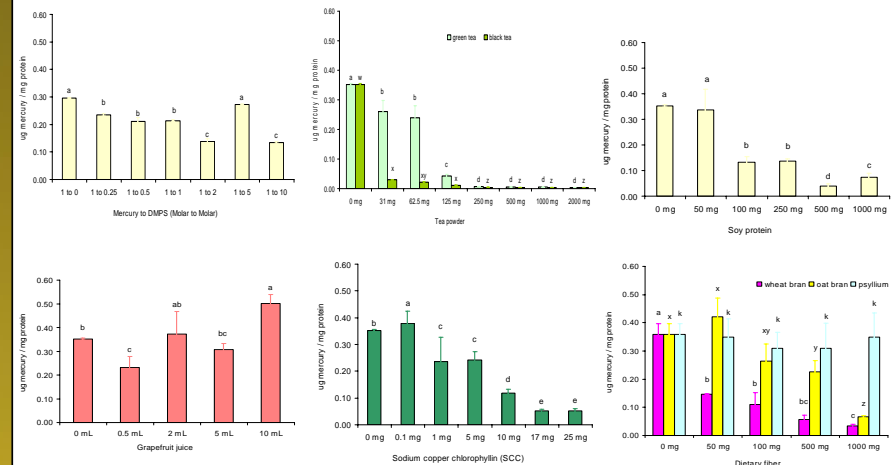


Figure 2. Impact of phytochemical-rich foods on methylmercury absorption by TC7-Clone of Caco-2 cells

CONCLUSIONS

- Phytochemical-rich foods or food components, such as green tea, black tea, soy protein, SCC, or wheat bran, reduced mercury bioaccessibility and inhibited methylmercury uptake by human intestinal cells.
- These phytochemical sources may be more efficient than synthetic chelating agents (e.g., DMPS) for treating methylmercury exposure
- This *in vitro* digestion model coupled with Caco-2 absorption may be a rapid and cost-effective alternative for evaluating total bioaccessibility of methylmercury in fish.

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