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Effect of boiling time on radionuclide concentration in seafood

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ABSTRACT

Objective: To reveal the effect of boiling time on radionuclide concentrations in seafood by investigating boiling-represented cooking practices, in order to fill the knowledge gap on how boiling time affects human radiation exposure.
Methods: A total of 13 seafood species of four categories (fish, crustacean, mollusk and algae) were collected from the coastal areas of China and analyzed for radionuclide contents left after boiling at 5, 10, 20 and 40 min under 100°C. Gross α and β, ^{40}K, ^{226}Ra, ^{232}Th, ^{137}Cs were measured using the low background α and β counter and the gamma-spectrometer.
Results: The contents of radionuclides decreased significantly with the increasing boiling time. The average retention rate of α-emitting radionuclide in in fish, crustacean, mollusk, and algae decreased to 64.47%, 53.34%, 84.12% and 62.63% after 5 min of boiling, respectively, and then to 15.46%, 14.21%, 71.94%, and 27.27% after 40 min, respectively. The average retention rate of β-emitting radionuclide in in fish, crustacean, mollusk, and algae decreased to 64.89%, 43.43%, 66.55% and 63.30% after 5 min, respectively, and then to 47.90%, 29.01%, 45.96%, and 53.24% after 40 min. The greatest loss of solubility was observed for ^{40}K with the average retention rate of 47.16% after 10 min, and higher retention rate of 87.86% and 90.03% in ^{226}Ra and ^{232}Th, respectively.
Conclusion: Boiling is effective in reducing the radionuclide content, with the committed effective dose (CED) reduction of 44.6% achieved by boiling for 10 min, mainly due to the reduction in ^{40}K. A full assessment will also be needed to incorporate more radionuclides (^{210}Po, ^{210}Pb, ^{228}Ra) into the calculations.

1. Introduction

Natural radionuclides and artificial radionuclides enter the marine environment either directly as a result of nuclear accidents and discharges from nuclear installations and nuclear weapons testing,[1] or indirectly through diffusion through various media such as air, water or soil, as shown in Fig. 1.[2,3] After entering the marine food chain, radionuclides are retained or transferred in the food chain.[4,5] Seafood is an important part of diets[6] and the ingestion of radionuclide-contaminated seafood may increase the hazards to human, especially infants, children and pregnant women. Therefore, understanding the factors affecting the contents of radionuclides in seafood is essential to ensure food safety and public health.

Cooking is a basic food preparation method that can alter the chemical composition and nutritional value of food. Numerous studies have focused on the effects of cooking on macronutrients, vitamins and minerals,[7,8] but limited researches were conducted on the effects of cooking on radionuclide contents. Current studies have focused more on the effects of cooking methods, such as boiling, grilling, frying, on radionuclide contents in food.[9–11] For example, Uddin et al.[11] focused on the effect of cooking methods on ^{210}Po loss in different types of seafood. However, there are few studies in the existing literature dealing with the effect of cooking time on radionuclide contents in seafood.

The aim of this study was to investigate the effect of boiling time on radionuclide contents in seafood, focusing on commonly consumed species such as fish, shellfish, crustaceans and algae. This study aims also to gain insights into how boiling time affects radiation exposure from radionuclides, by analyzing the changes in radionuclide contents at different boiling times. This study could help develop guidelines for safe seafood boiling and ultimately reduce the health risks associated with radionuclide intake.

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