Lead Absorption in Man from Dietary Sources

The Effect of Cooking upon Lead Concentrations of Certain Foods and Beverages

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Summary. The change in lead concentrations in foods and beverages has been examined during cooking processes in aqueous lead solutions. All of the foods examined—carrots, cabbage, peas, and macaroni—showed a significant uptake of lead in excess of the quantity of water regain that took place during cooking. Lesser quantities of lead were taken into carrots when cooked in solutions containing various concentrations of sodium chloride. Conversely, there were decreases in the concentrations of lead in both tea and coffee during preparation. A linear association between the concentration of lead in running tap water and kettle water in samples suggested that kettles do not contribute further to lead exposure. These experiments emphasize the dangers to man of lead exposure from domestic water supplies.

Key words: Lead – Water – Cooking – Diet

Research on the influence of lead in drinking water upon the body burden of lead has clearly demonstrated that such a source of exposure to lead constitutes a clearly definable hazard to organisms ingesting the water in which lead concentration is in excess of the currently defined acceptable limits (World Health Organization—0.48 μM; Environmental Protection Agency (USA)—0.24 μM). Indeed, such exposure to excessive water lead concentrations has been associated with specific health effects in humans (Moore, 1977) and following on this, a curvilinear association between water lead concentrations and blood and tooth lead concentrations has been demonstrated (Moore et al., 1977, 1978). In all cases, however, the fit of the regression line of water lead on blood lead has not been as good as expected, and this has been attributed to variations in alternative sources of lead exposure.

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To date, it has been generally assumed that the principal component of the water exposure vector is through consumption of the raw water and subsequent absorption of lead from it. The effects of cooking processes have seldom been taken into consideration. Until recently, it was generally thought that during cooking there would be loss of lead from the foods into the cooking medium in a manner similar to that found when vegetables and fruits are washed to remove superficial contamination by lead. Initial studies, however, indicate that there is positive uptake of lead into foods during cooking processes (Berlin et al., 1977). It is obvious that during the water regain phase of reconstitution of dehydrated foods there will be not only a considerable gain of water, but also an increase in the concentration of lead within the food which will be at least proportionate to the water lead concentration. Most studies examining lead content of food have considered only the lead content in the uncooked food (Ministry of Agriculture, Fisheries and Food, 1975) and have taken little cognisance of the uptake of lead into the foods in subsequent preparation procedures. In some studies, however, it has been noted that there appeared to be significant uptake of lead into food during the cooking process (Heusghem et al., 1973; Berlin et al., 1977) and following on this study, it was decided to examine in more detail the uptake of lead into vegetables, pasta, and beverages during the cooking process, using radio-active lead tracers, and to attempt to relate this uptake to man.

Materials and Methods

In total, three vegetables—carrot, cabbage and peas; a pasta—macaroni; two beverages—tea and coffee; and kettle water were examined in these studies. All of the vegetables were grown by the author in the same plot of land. The macaroni was a domestic product, purchased from a local store. The tea used was either as tea bags or loose tea, and coffee was fresh, medium-ground coffee of a 50:50 Columbian half-roast blend, suitable for use in the coffee maker. All cooking was carried out in acid-washed Pyrex beakers; tea was prepared in a Pyrex beaker and coffee was prepared in a commercially available coffee-maker (Moka Express, Italy).

Vegetables and Pasta

For each of the vegetables and for the macaroni, the procedure was as follows: 1,200 ml 10 μmol/litre solution of lead chloride was made up in distilled water and to this was added 200 μCi of carrier-free $^{203}$Pb chloride (produced by M.R.C. Cyclotron Unit, Hammersmith Hospital, London). This stock solution was then used to prepare each of the working solutions for the study. These were of lead concentration 0.1, 1, 2, 3, 5 μmol/litre. In one experiment on carrots, the salt concentration of the solution was adjusted to 75, 150, and 300 mmol/litre sodium chloride, all at a lead concentration of 1 μmol/litre. Two 1-litre beakers were prepared each containing 500 ml of the solution under investigation. Each was covered with a watch-glass and one placed upon an electric hotplate and allowed to come to the boil. When the solution was boiling freely the same quantity of prepared vegetable or macaroni was put into the boiling solution and into the cold solution in the other beaker which was maintained at 20°C throughout the experiment. Samples of each vegetable were then removed at the following time intervals from each of the beakers: zero time, 1, 2, 3, 5, 10, 15, 20, 30 min. Following removal from the solution, each sample was rinsed twice in distilled water, blotted dry and put into a weighed plastic tube for gamma counting and weighed. Samples of the solution were taken before and after the cooking process. Gamma counting of all samples was carried out on a Wallac auto gamma counter measuring the $^{203}$Pb principal peak at 280 kev and