Since April 29, 1986, the radioactive contamination resulting from the accident of the Chernobyl reactor has been measured in various kinds of matrices, with particular regard to Northern Italy. Here we present the data obtained for $^{137}\text{Cs}$ from several measurements effected on milk and dairy products over the period of one year. In particular, we have studied the transfer kinetics of $^{137}\text{Cs}$ from forage to milk by feeding dairy cows with forage of known activity and we have evaluated the body Cs absorption by measuring the percentages of Cs eliminated with milk as well as with urine and feces. Further, the decay rate of $^{137}\text{Cs}$ in milk has been assessed and the results of the kinetic analysis are reported. We have also evaluated the efficacy of various clay materials in removing Cs from milk. Here we report the results of adsorption kinetics for the grey clay which resulted the most effective material.

Introduction

Following the accident at Chernobyl, Northern Italy experienced some of the heaviest radioactive fall-out in Western Europe. Since April 29, 1986 our laboratory began taking a series of measurements which are still underway, to study environmental radioactive contamination in Northern Italy. This paper reports the results obtained over the period of one year in one matrix, that of milk and dairy products, which represents one of the main passages in the transfer of radioactivity from the environment to the human organism. In this instance, the problem of removing Cs from milk assumes particular importance, especially as regards "at risk" categories such as babies and pregnant women.

Therefore, the adsorption of Cs from milk by means of argillaceous materials was studied, in order to babies a simple method for removing this radionuclide in the event of radioactive contamination.
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Experimental

Materials

Green, grey and red clays, all for use in food products, were bought on the market; kaolinitic clay, bentonite, and illitic-chloritic clay were kindly given by the Centro Ceramico, Facoltà di Ingegneria, Università di Bologna; zeolite in form of 2 mm pellets (molecular sieves, 0.4 nm) was obtained from Merck.

The radioactive tracer $^{137}\text{Cs}$, in chloride form, was supplied from Amersham International, Limited, England.

Activity measurements

A hyperpure Ge solid state detector (Ortec, GEM 10175) was used to identify $\gamma$-radioactive nuclides in milk and a NaI (Tl) detector (Silena, Mod Cato) for determining the activity of the samples spiked with the $^{137}\text{Cs}$ tracer. Both instruments were calibrated with sources of known activity. For the study of Cs removal from milk, unskimmed UHT milk of commercial origin (containing $^{137}\text{Cs} = 8$ Bq/l and $^{134}\text{Cs} = 3.4$ Bq/l) was contaminated with $^{137}\text{Cs}$ making a total of 147 kBq/l. Ten g/l of one of the materials being examined was added to each sample with the exception of the zeolite for which 200 g/l was used. The milk was continuously shaken at room temperature for the duration of the experiment. At preset intervals, 2 ml of the mixture was taken, centrifuged and the $^{137}\text{Cs}$ in the supernatant was measured.

Results and discussion

Radioactivity in milk and dairy products

Samples of milk and its derivatives, of commercial origin and collected from the dairies where cows were fed with contaminated and uncontaminated forage, were examined. The maximum $^{131}\text{I}$ concentration found in the first 15 days of May 1986 was detected in samples of sheep's milk (8700 Bq/l, on May 9, 1986), whereas in cow's milk the maximum concentration observed was 249 Bq/l for cows fed with fresh forage. Milk of commercial origin had an average $^{131}\text{I}$ content of 105 Bq/l with the extremes ranging from 51 to 171 Bq/l during the period May 6--9. The concentration of $^{131}\text{I}$ in milk was strictly correlated to the type of animal feeding and was below the detectable limit when the cow was fed with hay harvested the previous year. A slight increase in the radioactivity in dairy milk collected in the month of May '86 was found immediately, even if the cow was only occasionally fed with fresh forage.