# HUMAN MILK RADIOACTIVE CONTAMINATION

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ABSTRACT

Strontium 90 concentration in human breast milk - collected in Rome from May 1986 to December 1988 - was measured. The EPA recommended method was set up, with some modifications. Concentrations range from the lower limit of detection (5-16 $mBq \cdot kg^{-1}$) to 58 $mBq \cdot kg^{-1}$. The committed effective dose from Sr-89 and Sr-90 to breast-fed infants, calculated utilising well-defined hypotheses, was in the order of 3 μSv.

## INTRODUCTION

Research on radioactive caesium in human milk due to the Chernobyl fallout has been conducted in Italy since May 1986. Gamma spectroscopic measurements with high purity germanium detectors were made from May 1986 to December 1988 on pooled samples (from 5 to 10 nursing mothers in the first week after delivery)(1) and in 1989 on samples from individual women in a planned ad hoc study(2).

Caesium transfer factor from a mother's diet to her milk was assessed in both situations. The values agreed with the result obtained during the fallout period in the sixties - due to weapon tests - and with other values published after 1986 (see discussion in ref.2). Caesium 137 was studied in greater detail because in the post-Chernobyl environmental contamination of Western European countries it appeared at the time to be the most significant radionuclide(3).

On the other hand, strontium 90, the most significant radionuclide in the fallout period of the sixties, was fortunately quite low in the post-Chernobyl period: in Italy the Cs-137/Sr-90 ratio ranged from some hundreds to some tens. For this reason and because measurements are more complex and take more time, there is little environmental and human data available on strontium 90 after the Chernobyl accident. Therefore, in 1990 the authors decided to set up an experimental radiochemical procedure to measure strontium 90 concentration in the samples of human milk collected.

There were also other aims: i) to set up for the first time this experimental capacity in the Istituto Superiore di Sanità (National Institute of Health); ii) to gain experience in this experimental practice in order to promote it in environmental radioactivity laboratories set up in each Administrative District(4); iii) to evaluate the zero level of Sr-90 in human milk in case of possible future accidents.

## EXPERIMENTAL METHOD

In order to separate Sr-90 in human milk samples the method recommended by the EPA(5) for milk was chosen. The method consists of fixing on a ionic exchange resin both strontium and barium present in human milk. Calcium in milk is first complexed with EDTA to avoid its taking the place of the two other chemical species on the resin. Both barium and strontium are removed by a concentrated solution of sodium chloride. The former is separated manually by taking advantage of its capacity to precipitate as a chromate. Strontium is recovered as a carbonate.

The method had to be adapted to 0.4-0.5 liter samples and in order to get good and reproducible yields, the following modifications to the original procedure were necessary.

i) The procedures require adjusting the milk pH value to 5.2, before fixing it on the ion exchange resin with ammonia. Samples studied always showed a lower acid content and therefore, the pH correction had to be made with acetic acid.

ii) The barium separation as chromate was repeated twice (instead of once) because in this way both a purer strontium carbonate and a higher yield of the Sr/Ba separation were obtained.

iii) The duration and velocity of centrifugation were increased: the former was doubled, the latter was changed from 2000 to 3000 r.p.m..

The improvements obtained by means of these modifications were tested with the atomic absorption spectrophotometry technique(6).

The Sr-90 measurements were taken with a gas flow $\alpha/\beta$ proportional counter with low background (<1 cpm), consisting of four detectors with ultra-thin windows (260 $\mu g/cm^2$), plus one guard detector, shielded by 10 cm of lead. The beta plateau is $\geq$ 200 volt with a slope $\leq$ 2.5%. The efficiency of the detectors was determined with Y-90 and Sr-90 filter sources, prepared with EPA methodology for standard sources, with the same geometry of the samples. The efficiency was found to be > 45% for Y-90 and > 40% for Sr-90. Both sources were monitored until Y-90 was either completely decayed or fully grown. On the Y-90 source this also permitted a check on the Sr/Y yield.

EXPERIMENTAL RESULTS

The filters obtained after the strontium separation in the samples were measured after having reached the Sr/Y equilibrium (that is after a minimum of 20 days). This allowed the filter to be counted over long periods (18-23 hours), thus reducing the high statistical error due to the very low activity of the samples.

The Sr-90 concentration in the pooled samples in the Rome area from May 1986 to December 1988 is shown in Figure 1. About 10 samples were found to be lower than or equal to the lower limit of detection(5) (in the range of 5-16 $mBq \cdot kg^{-1}$ depending on the experimental condition of each separation and count). The highest value was found in a 1986 sample equal to 58 $mBq \cdot kg^{-1}$. The concentrations are given as $mBq \cdot kg^{-1}$ because the determination of the sample weights could be made with a smaller error. However, the mean density of the samples resulted to be 1.02 $kg \cdot l^{-1}$.

It is not possible to know if the measured Sr-90 concentrations in human milk are due only to Chernobyl fallout, because no data was available on Sr-90 concentration in Italian human milk in the eighties before the accident. On the other hand, in the same years data was available on Sr-90 concentrations in cow's milk due to previous fallout.

The EPA radiochemical method also allows Sr-89 concentration to be determined by counting the filters a second time after 6-7 days. In this case, Sr-89 had already decayed due to the time that elapsed between sampling and counting.

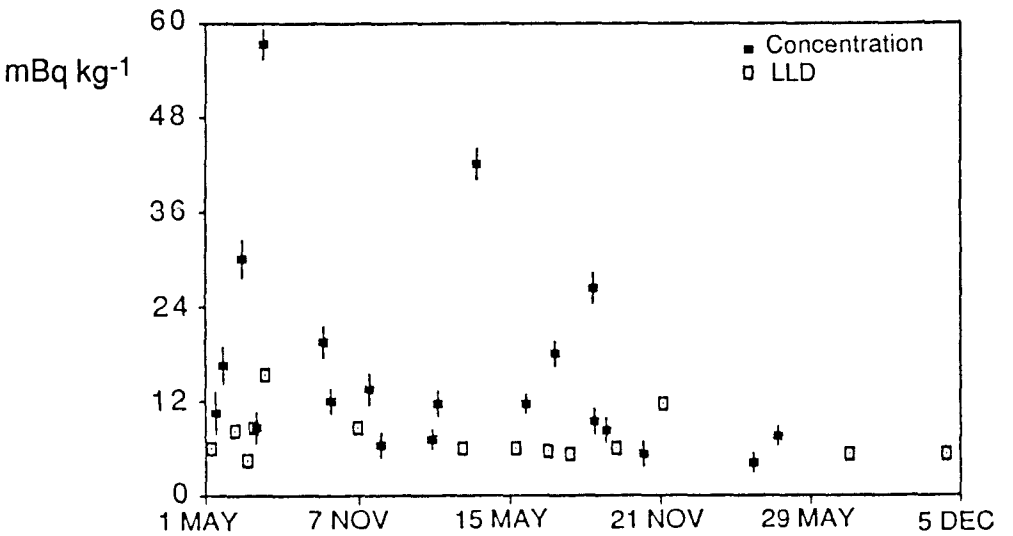


Fig.1 Sr-90 concentration in pooled breast milk samples from Rome over the period from May 1986 to December 1988. The measured values are given with one standard deviation, the LLDs at 95% C.L.

The dose from Sr-90 to breast-fed infants was calculated assuming a four-month breast-feeding duration and a milk ingestion rate of 0.7 $l \cdot d^{-1}$. Dose conversion factors calculated by the NRPB(7) in the light of the new ICRP Recommendations were used. Even if Sr-90 concentration had been constant for the first four months after the accident at the highest level measured, the committed equivalent dose to bone surface in the infant would have been equal to 14 μSv and the committed effective dose to about 1.3 μSv.

In order to estimate the effective dose from Sr-89, the Sr-89/Sr-90 ratio was assumed equal to 10 as it ranged approximately from 15 to 5 in Italy during May 1986(8). In the same hypotheses used for the calculation of the dose from Sr-90, the committed effective dose to breast-fed infants from Sr-89 was assessed in the order of 1.5 μSv in the first four months after the Chernobyl accident.

These doses are negligible and the effective doses are even lower than that previously calculated for Cs-137 in the same samples (see ref.1). Such low doses to infants could also be related to the ban on the consumption of cows' milk and leafy vegetables for pregnant and nursing women and children under ten imposed in Italy in May 1986.

Finally, by using the values of Cs-137 concentrations previously measured in the same samples(1), the Cs-137/Sr-90 ratio in 1986 was calculated. The range obtained for this ratio is compared with those measured in cow's milk in some Italian Districts(8,9) in Table 1.

Table 1. Strontium 90 concentration and Cs-137/Sr-90 in human milk and in cow's milk in some Italian Districts (1986).

| District | Sample | Sr-90 ($Bq \cdot l^{-1}$) | Cs-137/Sr-90 |
|---|---|---|---|
| Lazio(Rome area) | Human milk | <0.005-0.059 | 27-538 |
| Lazio(Rome area) | Cow's milk | <0.05 -0.28 | 22-161 |
| Lazio | Cow's milk | <0.05 -0.82 | 22-311 |
| Piemonte | Cow's milk | 0.09 - 2.4 | 4-246 |
| Lombardia | Cow's milk | 0.11- 0.79 | 109-146 |

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