AIR TO MILK TRANSFER OF CESIUM-137

C.Papastefanou

Nuclear Physics Department
Aristotle University of Thessaloniki
Thessaloniki 54006 Greece

ABSTRACT

Cesium-137 data in air,grass and cow`s milk are presented over a 4-y period (July 1987 - September 1991) The Cs-137 transfer rates in cow`s milk and grass, C_m/C_g ranged between 0.032 and 1.82 kg/l, while the transfer rates in cow`s milk and air, $C_m/C_a$ ranged between 4470 and 163350 $m^3/l$. Both the Cs-137 transfer rates were decreased with time passing depending on the Cs-137 concentration of cow`s milk, C_m which was decreased with time passing.

INTRODUCTION

Milk is one of the sources for ingestion of Cs-137 in the air-grass-cow-milk-man pathway[1-3] and is considered to be a major pathway of exposure to fallout radioactivity[4]. The Cs-137 content of cow`s milk was examined over a 4-y period after the reactor accident at Chernobyl (26 April 1986) starting from July 1987. This paper reports data obtained on the basis of continuous monitoring, in order to study transfer phenomena of Cs-137 from air to cow`s milk, via the air-grass-cow-milk pathway and explore the possible relation between the Cs-137 concentrations of milk, grass and air. The Chernobyl accident provided a unique opportunity for a such study because of large releases of reactor-generated radionuclides, transport over long distances and dry and particularly wet deposition on pasture or root uptake.

EXPERIMENTAL METHODS

Cow`s milk samples (1 kg each) from local dairies were collected at the beginning of each month from two different regional milk plants AGNO Milk Industry and MEVGAL Macedonian Milk Industry, in the Thessaloniki area, in Northern Greece (40^o 38'N, 22^o 58'E). In parallel, air sampling was carried out using Staplex high-volume air samplers,model TFIA-2 with Staplex type TFAGF 810 Glass Fiber filters 20.3x25.4 cm^2 (8"x 10") with an average flow rate of 1.84 m^3/min (65 ft^3/min), in order to determine the Cs-137 concentration of air. Grass samples were cut from an area of ~3 m^2 (0.125 kg grass per m^2) for each sample.

The Cs-137 content of milk,grass and air samples was counted using a high-efficiency (42%), high-resolution (1.9 keV at 1.33 MeV), low-background Ge spectrometer in a standard geometry (6 cm diameter plastic can for air samples and 1-L Marinelli beaker for milk and grass samples. The gamma spectroscopic system was calibrated using NPL (National Physical Laboratory,UK) standard reference sources in both cases, the overall efficiency being known to accuracies of better than 5% for the filter (plastic can) geometry and about 12% for the Marinelli beaker.

RESULTS AND DISCUSSION

Cesium-137 data were obtained for air, grass and cow's milk for the AGNO and MEVGAL regional milk plants over a 4-y period after the Chernobyl accident (26 April 1986) starting from July 1987. A summary of annual data of Cs-137 for the period 1987-1991 is presented in Table 1. Unusual high Cs-137 level in air was measured in July 1987 (0.166 mBq/m^3), August 1990 (0.250 mBq/m^3) and June 1991 (0.154 mBq/m^3), in grass (June 1990: 77.73 Bq/kg) and in cow's milk (July 1987: 33.49 and 39.96 Bq/l for the AGNO and MEVGAL milk plants, respectively). The ratio of Cs-137 to Cs-134 in air, grass and milk samples was as expected because of decay reasons. Although the Cs-137 concentration in air and grass had not significantly been changed on annual basis, whereas the Cs-137 concentration in cow's milk was decreased with time passing, indicating that the Cs-137 concentration in cow's milk depends not only on the grass but other contaminated food for which Cs-137 concentration was decreased with time.

Table 1. Summary of Cs-137 concentrations in air, grass and cow's milk

Year	Air $\times 10^{-5}$ Bq/m^3	av.	Grass Bq/kg	av.	AGNO milk Bq/l	av.	MEVGAL milk Bq/l	av.
1987	6.29-16.61	9.13	2.67-19.28	6.83	4.2 - 33.49	10.76	6.5 - 39.96	14.19
1988	3.03 - 7.50	5.09	1.96-20.60	7.17	1.96-10.20	4.90	1.84-16.40	6.09
1989	1.50 - 5.35	2.98	2.48-23.30	7.91	0.27 - 4.91	1.96	0.44 - 4.72	2.29
1990	1.23-25.00	4.59	1.12-77.73	10.71	0.15 - 0.73	0.41	0.27 - 2.19	0.79
1991	1.07-15.00	3.53	1.14-25.20	6.45	0.13 - 0.32	0.23	0.14 - 0.93	0.44

Cesium-137 transfer rates, C_m/C_g (kg/l) and C_m/C_a (m^3/l), where

C_m is the average concentration of Cs-137 in cow's milk (Bq/l),

C_g is the average concentration of Cs-137 in grass (Bq/kg) and

C_a is the average concentration of Cs-137 in air (Bq/m^3)

were determined based on the data corresponding to the period of April-September each year as the cows were mainly fed on grass that period. A summary of the data is presented in Table 2.

Table 2. Cesium-137 transfer rates in cow's milk

Period	$C_a \times 10^{-5}$	C_g	C_m AGNO	C_m MEVGAL	C_m/C_g AGNO	C_m/C_g MEVGAL	C_m/C_a AGNO	C_m/C_a MEVGAL
Jul-Sep 87	11.52	10.36	14.57	18.82	1.41	1.82	126504	163339
Apr-Sep 88	5.57	4.85	5.25	6.21	1.08	1.28	94196	111521
Apr-Sep 89	2.45	4.77	2.01	2.57	0.42	0.54	82053	104906
Apr-Sep 90	6.69	15.20	0.49	0.98	0.032	0.064	7283	14646
Apr-Sep 91	4.85	4.19	0.22	0.44	0.052	0.106	4466	9163
Average					0.60	0.76	62900	80715

The ratio C_m/C_g ranged between 0.032 and 1.41 kg/l for the milk of AGNO milk Industry and between 0.064 and 1.82 kg/l for the milk of MEVGAL milk Industry. The lowest values are pretty close to those referred in the literature[4], e.g. 0.022 or 0.023 kg/l for grass.

The ratio C_m/C_a ranged between 4470 and 126500 m^3/l for the milk of AGNO and between 9160 and 163350 m^3/l for the milk of MEVGAL. The data of Table 2 shows that the Cs-137 transfer rates, C_m/C_a for both milk plants were decreased with time passing depending on the Cs-137 concentration of milk, C_m which was decreased with time. Very low values of C_m/C_a as low as 71 and 200 m^3/l have been reported in the literature[4].

Papastefanou et al. (1991)[5] reported that there is a dependency of Cs-137 in milk with air concentration of Cs-137 (high correlation coefficients r=0.74 for the AGNO milk and r=0.84 for the MEVGAL milk).

REFERENCES

1. Wilson, D.W., Ward,G.M. and Johnson, J.E., 1969, A quantitative model of the transport of Cs-137 from fallout to milk. In:Environmental contamination by radioactive materials, IAEA STI/PUB/226, 736p.

2. Albini, E., Mascaro, L. and Belletti, S., 1990, Measurements of radiocesium transfer to milk and calculations of resulting dose in Brescia, Italy, following the Chernobyl accident, Health Physics, 59, pp. 455-460.

3. Ward, G.M. and Whicker, F.W., 1990, Milk distribution and feeding practice data for the pathway model, Health Physics, 59, pp. 637-643.

4. Tracy, B.L., Walker, W.B. and McGregor, R.C., 1989, Transfer to milk of I-131 and Cs-137 released during the Chernobyl accident, Health Physics, 56, pp. 239-243.

5. Papastefanou, C., Manolopoulou, M., Stoulos, S. and Ioannidou, A., 1991, Seasonal variations of Cs-137 content of milk after the Chernobyl accident, Health Physics, 61, pp.889-891.

A plot illustrating the Cs-137 concentrations in milk and grass is shown in Fig.1. C_m is the Cs-137 concentration in milk, in Bq/l, C_g is the Cs-137 concentration in grass, in Bq/kg. a. AGNO Milk Industry, b. MEVGAl Macedonian Milk Industry.

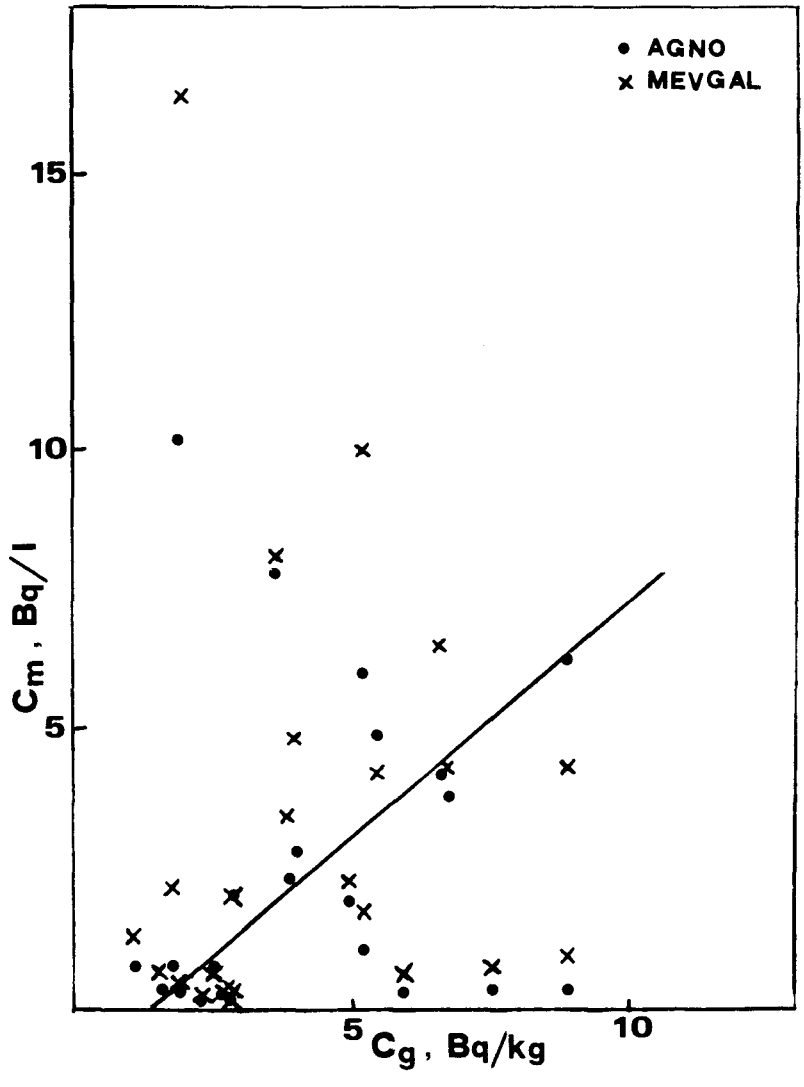

Fig.1. Cesium-137 concentrations in milk and grass for the period April-September each year from 1987 to 1991.