Bull. Environ. Contam. Toxicol. (1996) 57:549-555

Bulletin of Environmental Contamination and Toxicology

Toxic Metals in Food Products Originating from Locally Reared Animals in Kuwait

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Received: 10 January 1996/Accepted: 14 April 1996

The toxicity of certain heavy metals such as Pb, Hg and Cd is well documented (Lippmann, 1990; Mitsumori et al., 1990; Lohani and Muttamara, 1978; Davies, 1991; Watanuki, 1978; Friberg et al., 1985 and 1986).

The effect of environmental pollution on contamination of foods and on their safety for human consumption is a serious global public concern, and data on this subject have been reported by several investigators (Alegria et al., 1990; Ellen et al., 1989; Sherloock, 1987).

Since traces of heavy metals are found in almost every food commodity, an estimation of the intake of food contaminants is essential and differs considerably from country to country (Louekari and Salminen, 1986). In Kuwait, data are not available on the levels of toxic metals in foods consumed by the various age groups nor are there any Kuwaiti standards at present on the permissible limits of these metals in various food commodities. Hence, the dietary intake of these elements cannot be determined accurately.

The aim of this study was to investigate the levels of certain toxic metals in locally produced animal products.

MATERIALS AND METHODS

Samples of animal products including sheep and goat livers and kidneys, chicken livers, eggs, and cow and sheep milk were randomly collected from locally reared animals. The number of animals and total number of samples collected are shown in Table 1. All animals were purchased from local livestock wholesalers! except for the egg, and cow and sheep milk samples which were donated by the Public Authority for Agriculture and Fisheries (PAAF).

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Table 1. Number of animals and total number of samples of food commodity collected from each species

Species	Total	Liver	Kidney	Milk	Eggs
Goat	11	11	11	NS	NS
Sheep	16	16	16	NS	NS
Chicken	33	33	NS	NS	NS
Milking cow	22	NS	NS	47	NS
Milking sheep	22	NS	NS	30	NS
Laying hen	102	NS	NS	NS	190

NS = Not sampled.

The amount of sample collected varied for the different products. Usually 200 and 500 mL of sheep and cow milk respectively, were sampled. The liver and kidneys are target tissues for monitoring contamination because both organs concentrate metals. Usually the kidneys and liver of the slaughtered animals were taken whole, except for the livers of chickens, which were pooled to provide samples of sufficient size for analysis, i.e., three livers from chickens from the same area were pooled together and homogenized. Eggs were collected from laying hens on a daily basis. Each sample comprised five eggs from a laying hen were pooled together.

Kidney and liver samples were homogenized and stored in labeled plastic bags at -18 °C. Egg and milk samples were freeze-dried upon receipt and stored in labeled sample containers at -18 °C until analyzed.

For the determination of heavy metals in the food commodities, samples were digested as follows: approximately 1 g of the freeze-dried sample or 3 to 5 g of fresh sample was placed in a 100-mL beaker. Then, 10 mL of concentrated nitric acid was added to the sample, and the beaker was covered with a watch glass. The sample was then heated gently at 150 °C for 30 to 45 min. The resulting solution was cooled, and 5 to 10 mL of 72% perchloric acid was added slowly. The solution was then gently heated at 200 °C until digestion of the sample was complete, i.e., a clear solution was obtained. The solution was transferred into a 25-mL volumetric flask and made up to 25 mL with deionized water.

The concentrations of the toxic metals were determined using an inductively coupled plasma-mass spectrometer (ICP-MS) model VG-Plasma Quad. The ICP-MS's instrumental parameters were forward power of 1350 watts, plasma gas flow of 13.51 L/min, auxiliary gas flow of 0.91 L/min and nebulizer gas of flow 0.85 L/min. The recoveries were determined by analyzing a certified standard reference oyster tissue (SRM-1566a) obtained from the National Institute of Standards and Technology (NIST), Gaithersberg, USA for Hg, Cd and Pb content. Mean recoveries for the different elements ranged from 89% for Pb to 92% for both Hg and Cd.

RESULTS AND DISCUSSION

The Codex Alimentarius Commission (FAO/WHO, 1984) has established the maximum permissible concentration of metals in some food commodities; however, other foods such as meat, internal organs, eggs and milk were not included. Hence, the member states in the Codex Alimentarius Commission have adopted their own maximum permissible levels for metals in these food commodities. The levels of the toxic metals in the various food commodities investigated are presented in Table 2. As is shown, Hg was not detected in any of the samples examined, nor was the legal provisional Cd concentration of 500 µg/kg for liver as set by Germany (Avigdor, 1987) exceeded in any of the liver samples examined. Among the liver samples, chicken liver had the highest mean Cd concentration (89 µg/kg), followed by goat liver (47 µg/kg); whereas, sheep liver had the lowest mean Cd concentration (44 µg/kg). As for the kidney samples, the maximum permissible concentration of Cd (1000 µg/kg) set by some countries, e.g., Hungary (Code of the Hungarian Health Ministry, 1985) was not exceeded, except in one goat kidney sample (1250 µg/kg), as shown in Table 2. Furthermore, elevated mean Cd levels were detected in both goat and sheep kidneys (442 and 301 µg/kg respectively). This could be due to the fact that Cd is known to concentrate in the kidneys and livers of animals (Browning, 1969). Moreover, Cd is largely bound to sulfhydryl groups in the protein metallothionein in the kidney and liver organs; the formation of this protein is mainly caused by Cd ingestion (Verma et al., 1978) .

Table 2. Hg, Cd, Pb, Ni and V contents in various food commodities

Food type	N	Cd Mean	Range	Pb Mean	Range
Sheep liver	16	44	5-68	125	26-403
Sheep kidney	16	301	14-904	145	68-614
Goat liver	11	47	22-110	130	61-233
Goat kidney	12	442	73-1250	427	55-3496
Chicken liver	33	89	42-183	104	21-432
Chicken egg	190	7	ND-23	81	ND-225
Cow milk	47	ND	ND	43	ND-58
Sheep milk	30	ND	ND	ND	ND

All values are given in μg/kg wet weight.
ND = Not detected.
N = Number of samples.
Hg was not detected in any of the samples analyzed.

Telford et al. (1982) conducted a toxicological study in which field corn was grown on subsoil with a pH of 5.5, that had been amended with 100 t/acre of municipal sewage sludge from Syracuse, New York. The resulting corn plants, containing 3.88 ppm Cd on a dry-weight basis, were field-chopped and ensiled, and the silage was fed to growing sheep for 225 d. The results showed that the sheep fed the sludge-grown corn silage had higher concentrations of Cd in their livers and kidneys than did the control animals (2.91 ppm in the control kidney, 0.30 ppm in the control liver, 17.84 ppm in the sludge kidney, and 3.19 ppm in the sludge liver). In New Zealand, Solly et al. (1981) measured the Cd concentration in the kidneys and livers of clinically normal cattle, calves and sheep. Their results are as follows: 250 μg/kg in cattle and sheep kidneys and 100 μg/kg in cattle and sheep livers.

The maximum permissible concentration of Cd recommended by Hungary (Code of the Hungarian Health Ministry, 1985) for eggs i.e., 20 μg/kg, was not exceeded in most of the egg samples analyzed; only one egg sample exceeded the maximum limit with 23 μg/kg of Cd. Cd also was not detected in any of the sheep or cow milk samples.

The maximum legal provisional Pb limit of 2000 μg/kg in liver and kidneys as recommended by Sweden (Avigdor, 1987) was not exceeded in any of the liver and kidney samples investigated except for one goat kidney sample (3496) μg/kg). Nevertheless, elevated mean Pb concentrations were detected in both goat and sheep kidney samples (427 and 145 μg/kg respectively) as well as in goat and sheep liver samples (130 and 125 μg/kg), as shown in Table 2. This could be attributed to grazing animals near highways (in the presence of lead emission from car exhaust systems) which is widely practiced in Kuwait, especially during the winter and spring seasons when desert plants become plentiful. This practice might contribute to the elevated Pb concentrations in both goat and sheep kidneys. Likewise, the statutory limit of 300 μg/kg of Pb in eggs as set by Hungary (Code of the Hungarian Health Ministry, 1985) was also not exceeded in any of the eggs analyzed. As for the milk samples, the maximum provisional limit of 100 μg/kg of Pb as recommended by Hungary (Code of the Hungarian Health Ministry, 1985) was not exceeded.

In Canada, Salisbury et al. (1991) conducted a national survey between 1982 and 1989 to determine the amount of Pb residues in slaughtered animals. Liver and kidney tissues from cattle, poultry, calves and sheep were tested. The following range of lead concentrations were detected: 40 to 970 μg/kg in cattle liver, 40 to 2970 μg/kg in cattle kidney, 40 to 390 μg/kg in poultry liver, 40 to 1520 μg/kg in veal liver, 40 to 1580 μg/kg in veal kidney, 40 to 300 μg/kg in sheep and lamb liver, and 40 to 980 μg/kg in sheep and lamb kidneys.

Based on the results obtained in this preliminary study, it can be concluded that the levels of certain toxic metals in a majority of the food products investigated did not exceed the maximum allowable concentrations of metals recommended by different countries, except for one sample each of goat kidney and egg, which were higher than the legal provisional limits of Cd and Pb in some countries. However, it is of utmost importance at this stage to further investigate the levels of these toxic metals in other food commodities consumed by the different age groups and to assess the public health risks arising from the presence of these toxic contaminants in foods consumed by the Kuwaiti population.

Acknowledgment. The authors acknowledge the financial support of the Kuwait Environment Protection Council for this project.

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