CADMIUM IN LIVERS AND KIDNEYS OF ICELANDIC LAMBS

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Background

Food producers and food processors in Iceland are relying on extensive and environmentally friendly agriculture in the competition with lower priced products of intensive agriculture and countries with lower production cost. The geographical isolation of the country, cool climate, unpolluted air, unfertilized grazing areas and abundant supply of clean water makes it very suitable for production of foods with low levels of contaminants. The soil is, however, of volcanic nature in several areas and volcanic eruptions could contaminate grazing areas used for sheep.

High cadmium concentrations have been reported for Icelandic mosses in areas of volcanic activity and soil erosion[1]. The concentration was highest in an area running through the country from the south-west to the north-east and coincides very well with the zone of volcanic activity and soil erosion. The most likely source of moss cadmium in Iceland is soil. Airborne industrial pollution and phosphate fertilizers could also contribute to the cadmium level in lambs. Fertilizers produced and used in Iceland are claimed to contain very little cadmium[2]. A study in New-Zealand found that soil cadmium had increased as a consequence of high levels of cadmium in fertilizers[3].

Little cadmium is in the bodies of new-born lambs. Cadmium from feeds accumulates in kidneys and livers and the concentration increases with age. Livers and kidneys are used as indicator organs as cadmium accumulates there. The concentration is much lower in meat.

Objective

The first aim of the study was to evaluate the level of cadmium in livers and kidneys of Icelandic lambs. The second aim was to study the influence of soil type (volcanic/non volcanic) on the concentration of cadmium. The third aim was to investigate whether the accumulation of cadmium in mosses can indicate the level in lamb organs.

Methods

Samples of lamb kidneys and lamb livers were collected in 6 slaughterhouses in 1991 and 1992. The slaughter season was divided into 3 equal periods and samples were collected in the 1. period and again in the 3. period. Each time 4 samples were collected randomly (a sample contained organs from 5 lambs). During sampling, the names of the farms were recorded. 96 samples of each organ were collected. Besides this, samples from lambs grazing close to the mountain Hekla were collected (3 samples, 15 lambs) a few months after the volcanic eruption in 1991.

About 0.5 g samples were weighted into teflon bombs (Parr 4782) then adding 3 ml nitric acid and 2 ml hydrogen peroxide. Digestion was carried out under pressure for 3 minutes in a microwave oven. The contents of the bombs were poured into plastic test tubes. A Perkin Elmer 2380 atomic absorption instrument, with a HGA400 graphite furnace, was used for the analyses. Aliquots of clear digested samples were pipetted into the graphite furnace analysing cadmium at 228.8 nm with deuterium background correction. Three certified reference materials were used to ascertain the accuracy of the method.

Results and discussion

Cadmium content in Icelandic lamb kidneys and livers was very low and differed significantly between areas (see Table 1). The highest level was found for the west and north-west areas that have little volcanic activity. The lowest level was in South-Iceland where considerable volcanic activity and soil erosion exists. The levels of cadmium in the organs did not differ between the years 1991 and 1992. Cadmium in organs of lambs, that were grazing in the area of mountain Hekla a few months after volcanic activity, were 30 µg/kg for liver and 55 µg/kg for kidneys. These values are within the total range for this area. This does not indicate any serious cadmium contamination as a result of volcanic activity.

The cadmium levels in liver and kidneys of Icelandic lambs do not reflect concentrations found in mosses. Lambs always ingest some soil with the grass and therefore elevated cadmium levels were expected in lambs grazing in areas with soil erosion. In Norway, a relation between cadmium in moss and cadmium intake in lambs has been reported[8]. Cadmium deposition in mosses in Iceland is most likely soil cadmium but in other countries airborne pollution might be more important. The cadmium pattern in Icelandic lamb organs has not yet been explained.

The legal maximum concentration for cadmium in organs for human consumption is 500 µg/kg in the European Community. No sample in this study exceeded 51% of that level. A New Zealand study reported that 1% of lamb kidneys and 30% of sheep kidneys contained cadmium levels above the legal maximum (1000 µg/kg at the time of the study)[4]. In an Australian study 2% of lamb kidneys were found to contain cadmium levels above 1000 µg /kg[5].

Table 2 compares average values for cadmium in lamb livers reported in studies from four countries. Cadmium in Icelandic lamb livers are among the lowest values reported. Comparison of results from different countries is difficult since cadmium in liver depends on age of the animals, soil conditions and cadmium in feeds.

Conclusions

1. The levels of cadmium in livers and kidneys of Icelandic lambs are very low. All samples had a cadmium content well below the maximum level set by the EC.
2. Cadmium in livers and kidneys differed between areas. Highest values were found in areas outside volcanic activity. On the other hand concentrations of cadmium in mosses are highest in volcanic areas. Deposition of cadmium in moss is not an useful indicator to evaluate the susceptibility of Icelandic lambs to contamination by this element.
3. The cadmium level of organs from lambs grazing in the vicinity of mountain Hekla a few months after its eruption do not indicate a significant contamination from volcanic activity.

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Table 1. Cadmium (µg/kg fresh weight) in livers and kidneys of Icelandic lambs.

Area	Number of samples	Cadmium in livers Mean (Range)	Cadmium in kidneys Mean (Range)
South	16	24 (9-52)	25 (7-58)
West	16	56 (14-230)	66 (19-242)
North-West	16	66 (35-130)	108 (53-254)
North	16	28 (15-52)	34 (14-70)
North-East	16	38 (11-129)	41 (12-114)
South-East	16	57 (25-208)	73 (14-185)
All areas	96	45 (9-230)	58 (7-254)

Table 2. Cadmium (µg/kg fresh weight) in lamb livers reported in studies from four countries.

Country	Number of samples	Cadmium Mean (Range)	Reference
Iceland (this study)	96	45 (9-230)	
Germany	207	48 (5-191)	6
The Netherlands	123	89 (<1-1890)	7
North-Norway	15	180 (90-320)	8
South-Norway	15	390 (40-850)	8