INVESTIGATIONS TO THE DISTRIBUTION OF CS-137 AND K-40 IN A COW

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INTRODUCTION

It is of particular interest to study the distribution of radionuclides in domestic animals after a long-term ingestion of radionuclides. We performed a study to determine the specific activities of Cs-137 and of the naturally occuring K-40 in different tissues, organs and in the gastro-intestinal tract of a cow. As a consequence of the fallout following the Chernobyl accident in April 1986, the cow ingested chronically heavily contaminated forage during four years. It is the aim of these investigations to find out regions of high activity concentrations in the cow and to compare the activity concentrations of Cs-137 and K-40 in the samples of the whole cow. Of particular interest are the activities of radiocaesium in edible tissues (meat) and organs.

EXPERIMENTAL PROCEDURE

The cow was slaugthered in November 1992 and dissected in anatomical parts. Samples of the whole body of the cow were taken during or immediately after slaughtering. Most of the samples had to be deep-frozen and were thawed before measuring. We performed exclusively mechanical procedures to separate complex structures to get samples in correspondence to their anatomical sites and their physiological function (1,2). The activities of Cs-137 and K-40 were determined simultaneously by gamma counting with the help of semiconductor-detectors and the usual software. Marinelli-beakers or small cylindrical containers of perspex were used as containers for the samples. Some samples containing fat and vascular systems were molten to obtain the activities of pure fat. Other samples were cleaned with water to get the activities of the pure parts.

EXPERIMENTAL RESULTS

All activities are related to November 14, 1992, the day of slaugthering. Values for the specific activities, for the activities and their ratios are presented with a confidence level of 2σ.

Muscle tissues

Table 1. Highest specific activities in muscle tissues.

	Spec. activ. Cs-137 (Bq/kg)		Spec. activ. K-40 (Bq/kg)
M. masseter	389.5 ± 20.7	M. semitendinosus	129.2 ± 6.2
M. gracilis	381.8 ± 6.6	M. iliopsoas	122.9 ± 4.5
M. pterygoideus	371.5 ± 33.3	M. longissimus dorsi (b)	122.2 ± 4.5
M. temporalis	354.6 ± 31.8	M. gracilis	121.8 ± 3.0
M. obturator	352.9 ± 22.3	M. splenius	120.6 ± 10.5
M. semitendinosus	352.9 ± 14.1	M. latissimus dorsi	119.0 ± 6.6
M. glutaeus	352.5 ± 6.5	M. triceps brachii	116.1 ± 4.1
M. iliopsoas	352.5 ± 8.7	M. quadriceps femoris	115.7 ± 3.5

Table 1 shows the highest specific activities of Cs-137 and K-40 observed in the muscle samples. The samples were measured without any special preparation and contained pure muscle tissues, tendons and remainders of fat. The values of the specific activities of Cs-137 and K-40 range from 213.0 Bq/kg (M. levator labii maxillaris) to 389.5 Bq/kg (M. masseter) and from 62.8 Bq/kg (M. buccalis) to 129.2 Bq/kg (M. semitendinosus), respectively. In all muscles of the head we found low specific activities of K-40, whereas high specific activities of K-40 were observed in the important edible muscle tissues. These tissues contain only less tendons.
High values of the ratio of specific activities of Cs-137 and K-40:
M. masseter > M. pterygoideus > M. temporalis > M. zygomaticus > M. buccalis.
All these muscles are located in the head.
Low values for this ratio:
M. cutaneus maximus < M. extensor digitorum lateralis < M. splenius < M. extensor digitorum communis < M. extensor carpi radialis.

Pure muscle tissues
These samples consisted of pure muscle cells, connective tissues were separated. Highest values of Cs-137 were found for M. masseter and M. gracilis: 415.0 ± 37.1 Bq/kg and 408.6 ± 10.9 Bq/kg, respectively. The specific activities of K-40 showed a moderate variation.

Tendons
Table 2. Specific activities of Cs-137 and K-40 in cleaned (washed) tendons.

	Spec. activ.Cs-137 (Bq/kg)	Spec. activ.K-40 (Bq/kg)
M. gastrocnemius	72.7 ± 8.7	25.8 ± 4.0
M. longissimus dorsi (f)	88.8 ± 10.8	25.8 ± 6.9

It was observed that flat-spread tendons accumulate more Cs-137 than tendons of other compact shapes.

Fat
The samples contained fat and vascular systems. The specific activities of Cs-137 in fat, correspond roughly to the activities of Cs-137 in the pure muscle tissues. In the rank of the specific activities of K-40 structures with great contents of pottassium (Ligamentum nuchae, Glandulae suprarenales) are included. Some samples of fat were molten and then the activities of pure fat were measured. The activity levels of Cs-137 and K-40 of the pure fat were found to be at the detection limits of the spectrometers (0.5 Bq - 1.0 Bq).

Lymph nodes
The highest specific activities of Cs-137 and K-40 were found in the lymph nodes of the head: (326.2 ± 39.7) Bq/kg and (89.5 ± 29.8) Bq/kg, respectively. Rank of the specific activities of Cs-137 in lymph nodes:
Head > Muscle tissues > Rumen > Kidneys > Udder > Mesenterium commune.
The specific activities of K-40 in different lymph nodes are within the confidence limits and may be considered nearly constant.

GI-tract
Values of the specific activities of Cs-137 and K-40 in all digestive organs are summarized in a previous work (3).

Organs

Data in Table 3 are valid for the activities of the pure samples without connective tissues.

Table 3. Specific activities of Cs-137 and K-40 in selected organs.

	Spec. activ.Cs-137 (Bq/kg)	Spec. activ.K-40 (Bq/kg)
Heart	196.2 ± 11.8	77.4 ± 7.5
Lung	135.4 ± 4.3	63.0 ± 3.2
Liver	194.1 ± 5.4	102.9 ± 4.2
Gall bladder	43.8 ± 2.2	25.3 ± 2.0
Pancreas	274.6 ± 24.6	106.3 ± 13.0
Kidneys	301.6 ± 10.9	62.1 ± 3.7
Spleen	217.0 ± 13.8	111.5 ± 10.0
Skin	35.8 ± 0.4	20.0 ± 0.4

Total Activities of Cs-137 and K-40

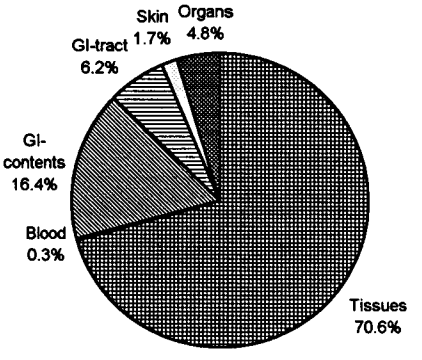

Fig. 1. Percentage of the activities of Cs-137 in different compartments.

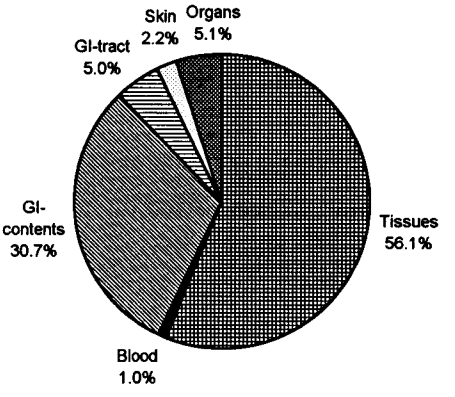

Fig. 2. Percentage of the activities of K-40 in different compartments.

The compartment "tissues" includes muscle tissues and connective tissues.. Total mass and total activities of Cs-137 and K-40 (without the compartment "GI-contents") were estimated to be 302 kg, 50.1 kBq and 21.7 kBq, respectively.

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