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^{137}Cs activity concentration in wild boar meat may still exceed the permitted levels

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Abstract

The radiocaesium activity concentration may still remain high in natural products such as game meat, wild mushrooms, and forest berries even more than two decades after the Chernobyl accident. The results of regular control studies of game meat conducted in Poland showed wild boars as the most contaminated game animals. It is well documented that some mushrooms, readily consumed by animals, show high ability to accumulate caesium radioisotopes. Bay bolete, one of the most wide-spread mushroom species in Poland, reveals a unique radiocaesium accumulation feature. Moreover, deer truffle, containing also particularly high levels of radiocaesium, could be another radionuclide source for wild boars. Furthermore, animals consuming deer truffles could digest contaminated soil components. Among 94 wild boar meat samples analysed in 2008–2009, two exceeded the permitted level. Hence, some precautions should be taken in the population with an elevated intake of wild boar meat. Moreover, since each hunted wild boar is examined for the presence of *Trichinella* larvae, regular measurements of radiocaesium concentrations in these animals may be advisable for enhancing consumer safety.

1. Introduction

An increased level of radiocaesium was noted in many foodstuffs in the early years after the Chernobyl nuclear accident. The radiocaesium concentrations

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Figure 1: Sampling scheme in the regions of Poland in 2008–2009.

have remained high in natural food products such as game meat, mushrooms and berries. It is postulated that the transfer of radiocaesium from soil via plants and mushrooms to animals is much higher in forest ecosystems than in agricultural environments, and that the radionuclide decrease is very slow [7–9, 15].

According to the Commission recommendation 2003/274/Euratom wild boar meat with a radiocaesium concentration higher than the maximum permitted level ($600\,\mathrm{Bq\,kg^{-1}}$) is banned from the market.

In Poland, wild boar samples are regularly measured for their radiocaesium content to follow the radioactive contamination status of the environment and ensure radiological safety for consumers (fig. 1, table 1).

The objective of the present work was to determine the current levels of radiocaesium in wild boar meat, and to assess the effective doses for consumers.

Table 1: Number of wild boar meat samples collected in the regions of Poland in 2008–2009.

Voivodeship	Sample number	
	2008	2009
dolnośląskie	8	6
kujawsko-pomorskie	5	3
lubelskie	3	5
lubuskie	6	5
opolskie	4	4
podkarpackie	1	1
podlaskie	7	3
warmińsko-mazurskie	5	4
wielkopolskie	6	–
zachodniopomorskie	12	6
total	57	37

2. Materials and methods

Wild boar muscle samples were taken at food processing facilities and then transported to regional veterinary hygiene laboratories for analyses.

Muscle samples were chopped, minced and put in $450\,\mathrm{cm}^3$ Marinelli beakers. The sample geometry was similar to that of the source used for the detector calibrations.

^{137}Cs and ^{134}Cs activity concentrations were determined by gamma-ray spectrometry using scintillation detectors (NaI(Tl), 2") (Scionix, The Netherlands) mounted in lead shields. Each measurement lasted 72,000 s.

For radiation dose assessment originating from ^{137}Cs, a dose conversion factor of $1.3 \cdot 10^{-8}\,\mathrm{Sv\,Bq}^{-1}$ was applied to assess the effective doses received by consumers [6]. The effective dose was defined by the equation

$$H_\mathrm{E} = A_k m D_{kf(k)}\,,$$

where H_E is the effective dose (Sv); A_k – the concentration of radionuclide k (Bq kg^{-1}); m – the quantity of consumed food (kg) and $D_{kf(k)}$ is the dose conversion factor for radionuclide k [16].

3. Results

The ^{134}Cs activity concentration was negligible (always below MDA values) in all the samples measured.

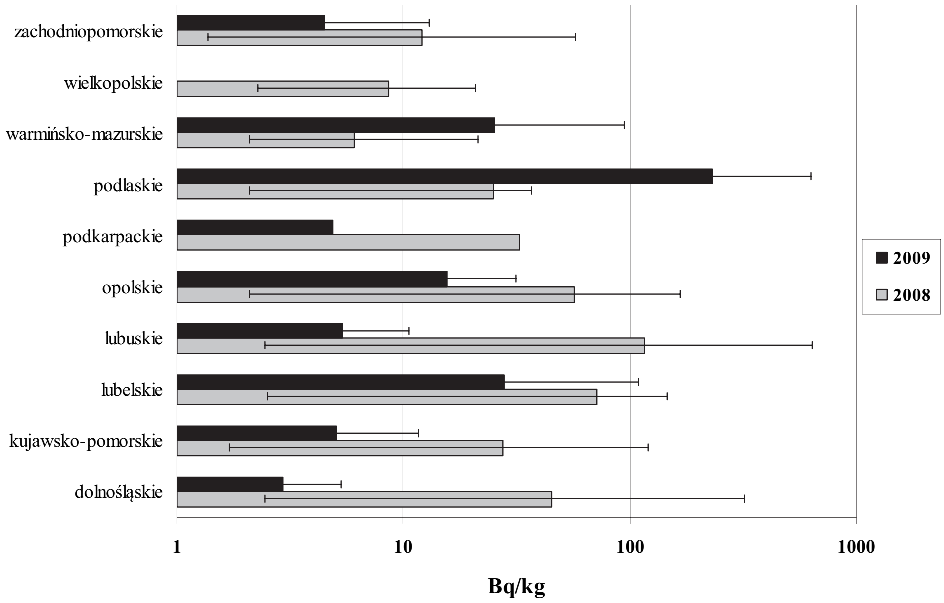

Figure 2: ^{137}Cs activity concentration in wild boar meat samples from the regions of Poland in 2008–2009; mean and range, (no error bars – only 1 sample analysed).

Table 2: Effective doses from consuming 1 kg of wild boar meat.

Sampling year	H_{E} per kg of meat (μSv)
2008	0.52
2009	0.47

The ^{137}Cs activity concentration was very variable. Even in the same region it ranged from MDA values to more than 300 Bq kg^{-1}. In two samples, the ^{137}Cs radioactivity concentration exceeded 600 Bq kg^{-1} (maximum permitted level). Average values and ranges of ^{137}Cs radioactivity concentration in the regions of Poland are shown in fig. 2.

Mean effective doses from consuming 1 kg of wild boar meat in 2008 and 2009 are presented in table 2.

For the wild boar meat samples with the ^{137}Cs activity concentration exceeding 600 Bq/kg, the effective doses of 8.26 and 8.17 μSv kg^{-1} was calculated for the years 2008 and 2009, respectively.

4. Discussion

The extraordinarily variable radiocaesium activity concentration in wild boar meat samples may be attributed to different levels even in neighbouring areas. No direct relationship was observed between the most contaminated areas in Poland during the Chernobyl accident and the highest radiocaesium levels noted currently in wild boars. It seems rather that the most important element determining the animal's radiocontamination would be the local deposition of radionuclides and wild boar's dietary habits.

Generally, ^{137}Cs activity concentration in wild boars in the regions of Poland is minor, anyhow, far below the permissible limits. Comparable results were obtained in meat of wild boars in Croatia [16]. Even lower levels were measured in animals from the vicinity of Belgrade [17]. However, considerably higher values up to 40,000 Bq kg^{-1} were noted in some areas of Germany [5, 13, 14].

Many authors observed the seasonal variations in radiocaesium concentration in wild boar meat. They ascribed this contamination pattern to the periodical mushroom availability for animals [3, 6, 13, 15].

It is well documented that some mushrooms, readily consumed by game animals, show a high ability to accumulate radiocaesium [2, 4, 10–12]. Bay bolete (*Xerocomus badius*), one of the most widespread mushroom species in Poland, reveals a unique radiocaesium accumulation feature. Dyes from its cap cuticle can complex caesium ions [1]. Moreover, deer truffle (*Elaphomyces granulatus*), also containing particularly high levels of radiocaesium, could be another radionuclide source for wild boars [5,13,14]. These mushrooms grow in a depth of 6–8 cm in spruce forest soil, which corresponds to a Oh/Ah (organic layer/mineral layer) horizon where high ^{137}Cs activities are still observed [12]. Moreover, animals consuming deer truffles may digest contaminated soil components. Steiner and Fielitz [14] investigated wild boar stomach contents to obtain detailed information on the food composition. They identified these mushrooms as the dominant source of ^{137}Cs for wild boars. Despite their low weight proportion of only about 6% of the stomach content, more than three quarters of the radiocaesium uptake can be ascribed to these fungi [14].

Average consumption of game meat in Poland is very low and the contribution of this sort of food to the effective doses received by consumers is negligible, with the exception of hunters and poachers together with their families.

Since each hunted wild boar in Poland is examined for the presence of *Trichinella* larvae, measurements of radiocaesium concentration in these animals may be advised for enhancing consumer safety.

In conclusion, some precautions may be taken in populations with elevated intake of natural food products.

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