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ABSTRACT

Rabbit meat is very valuable product for human consumption. In Poland many meat rabbit farms are located in highly polluted regions, where beside of existing industry, also other factors have recently started to play a vital part in environmental degradation (i.e. rapidly growing motorization). The region of Katowice city is located in southern Poland and it is the most polluted area in the country, but simultaneously the region, where traditionally rabbit raising is very popular and strongly developed. Especially heavy metals are recognised as the most dangerous compounds for human health. The purpose of presented study was an estimation how severe area pollution influences on bio-accumulation of some heavy metals in body tissues of both males and females. The main studies of 1999 have been preceded by pilot project accomplished in 1998.

INTRODUCTION

Compared with the meat of other species, rabbit meat is richer in proteins and certain vitamins and minerals. It also has less fat. Rabbit fat contains less stearic and oleic acids and higher proportions of the essential polyunsaturated linolenic and linoleic acids (Lebas et al. 1997).
The first reference to rabbit raising in Poland reaches back to X century. On the beginning of 90-ties the total production of rabbit meat in Poland reached yearly 25-26 thus tons. An introduction of economical and political changes in 1989, had a tremendous influence on rabbit raising. A free access of buyers from Western Europe, as well as lack of any official export to EU countries, caused a huge demand for rabbit meat. This simultaneously stimulated the process of creation of many small family meat rabbit farms (Bielański et al., 1996).
In the same time in Poland a rapid growth of motorization is being observed. In regions where the pollution was already high, because of existing industrial plants, factories, steel-works and coal-mines, the influence of quickly increasing number of cars is much more considerable and serious. The region of Katowice city is the most polluted one with heavy metals in Poland (Table 1).

Table 1.
Total highest and lowest emission of industrial air pollutants in Poland in 1998 (Ochrona Środowiska, GUS, 1999).

Highest emission – Katowice region (Tons/km$^{2)}$	Lowest emission – Białystok region (Tons/km$^{2)}$	Average for Poland (Tons/km$^{2)}$
4.6	>0.4	0.94

Such a severe pollution of the environment may lead to serious health problems as in rabbits as in humans then.
In the research we focused on examination of 3 heavy metals : nickel, lead and cadmium. Their harmful influence on organisms of land mammals, as well as levels of accumulation in the environment and body tissues have been described by Norberg (1972), Żmudzki (1978), Bohosiewicz (1979), Falandysz (1991), Gadd (1991), Kabata-Pendias, Pendias (1993) and Bodak, Dobrzański (1997).
The purpose of the study was to define how the level of area pollution influences the presence of heavy metals in kidneys, liver and muscles of young meat rabbits.

MATERIALS AND METHODS :

In 1998 (pilot project) 12 meat rabbits of White New Zealand (6 female and 6 males) in age of 3-4 months have been slaughtered. The samples from thigh muscle, kidneys and liver have been collected. The contents of heavy metals in the collective samples, mixed from all received samples, have been measured with reference to the sex.
In 1999 20 meat rabbits of New Zealand White (10 females and 10 males) in age of 3-4 months have been slaughtered. The samples from thigh muscle, kidneys and liver have been collected. The contents of heavy metals in each individual sample have been measured with reference to the sex.
The rabbits were raised on small breeding family farms, placed in industrial region in surrounding of Katowice city in southern Poland. Farmers kept them in traditional way in small wooden cages. They fed them mainly with feeds produced by their own, like: fresh forage, dried bread, grain mash, hay, peels, carrot, beetroot, turnip etc.
The content of nickel, lead and cadmium have been measured by GFAAS method, using indicators of MERCK Company. The GFAAS method is based on atomic absorption spectrometry using an atomizer process in graphite stove.

RESULTS AND DISCUSSION

The obtained results in the pilot and main studies are presented in the tables.

Table 2.
The contents (ppm) of Nickel in collective samples from kidneys, liver and muscles of young meat rabbits, (1998 trial).

Group	Low (<1.0 ppm)	Normal (1.0-2.0 ppm)	High (>2.0 ppm)
Kidneys			
Males	1	0	0
Females	1	0	0
Liver			
Males	1	0	0
Females	1	0	0
Muscles			
Males	1	0	0
Females	1	0	0

Table 3.
The contents (ppm) of Nickel in samples from kidneys, liver and muscles of young meat rabbits, (1999 trial).

Group	Low (<1.0 ppm)	Normal (1.0-2.0 ppm)	High (>2.0 ppm)
Kidneys			
No. of males	9	0	1
No. of females	9	0	1
Liver			
No. of males	10	0	0
No. of females	10	0	0
Muscles			
No. of males	9	0	1
No. of females	10	0	0

Table 4.
The contents (ppm) of Lead in collective samples from kidneys, liver and muscles of young meat rabbits, (1998 trial).

Group	Low (<0.2 ppm)	Normal (0.2-2.0 ppm)	High (>2.0 ppm)
Kidneys			
Males	0	1	0
Females	0	1	0
Liver			
Males	0	1	0
Females	0	1	0
Muscles			
Males	1	0	0
Females	1	0	0

Table 5.
The contents (ppm) of Lead in samples from kidneys, liver and muscles of young meat rabbits, (1999 trial).

Group	Low (<0.2 ppm)	Normal (0.2-2.0 ppm)	High (>2.0 ppm)
Kidneys			
No. of males	0	10	0
No. of females	1	9	0
Liver			
No. of males	0	10	0
No. of females	0	10	0
Muscles			
No. of males	7	3	1
No of females	6	4	0

Table 6.
The contents (ppm) of Cadmium in collective samples from kidneys, liver and muscles of young meat rabbits, (1998 trial).

Group	Low (<0.1 ppm)	Normal (0.1-0.5 ppm)	High (>0.5 ppm)
Kidneys			
Male	0	0	1
Female	0	0	1
Liver			
Male	0	0	1
Female	0	1	0
Muscles			
Male	1	0	0
Female	1	0	0

Table 7.
The contents (ppm) of Cadmium in samples from kidneys, liver and muscles of young meat rabbits, (1999 trial).

Group	Low (<0.1 ppm)	Normal (0.1-0.5 ppm)	High (>0.5 ppm)
Kidneys			
No. of males	0	0	10
No. of females	0	0	10
Liver			
No. of males	0	6	4
No. of females	0	7	3
Muscles			
No. of males	10	0	0
No. of females	10	0	0

The content of nickel in tissues of land mammals ranges between 1.0 – 2.0 ppm (muscles) and 1.0-3.0 (bones) (Kabata-Pendias, Pendias 1993), while in atmosphere it waves from 1.0-150 up to over 2,000 ng/m^3 in industrial areas (Kabata-Pendias, Pendias, 1993). In rabbits slaughtered in 1998, males and females, the content of nickel in all body tissues was low (< 1.0). In rabbits slaughtered in 1999 the high contents of nickel (> 2.0) were observed in kidneys of only 1 male (16.6 ppm) and 1 female (2.30 ppm). The contents in livers of all rabbits were low (the lowest rate was 0.05 ppm). The highest content in muscle of only 1 male was observed (15.9 ppm), while in 9 males and 10 females were low (the lowest rate was 0.005 ppm). The contents of nickel as in collective as individual samples were low in all body tissues.

The content of lead in tissues of land mammals ranges between 0.2-2.0 ppm (muscle) and 4.0-25.0 ppm (bones) (Kabata-Pendias, Pendias, 1993). The same authors present, that in atmosphere content of lead waves from 1.0 (North Pole) up to over 20,000 ng/m^3 in industrial areas. In rabbits slaughtered in 1998, males and females, the content of lead in kidneys and livers was normal (0.2-2.0 ppm). The content in muscles of both sex was low (< 0.2 ppm).
In rabbits slaughtered in 1999 the highest content of lead (15.9ppm) was observed only in muscle of 1 male. In kidneys of 10 males and 9 females the contents were normal (0.2-2.0

ppm). The content in only 1 female was low (0.15 ppm). The contents in liver of all rabbits, males and females were normal (0.2-2.0 ppm).
The contents of lead as in collective as individual samples were normal in kidneys and liver and either low or normal in muscles.

The content of cadmium in tissues of land mammals ranges between 0.1-0.5 ppm (muscles) and 0.5-1.5 ppm (bones) (Kabata-Pendias, Pendias, 1993). The authors mentioned, that in industry regions it can reach 2,000-4,000 ng/m^3. In rabbits slaughtered in 1998, males and females, the content of cadmium in kidneys was high (> 0.5 ppm). In liver the content was either normal (0.1-0.5 ppm) in females or high (> 0.5 ppm) in males. The content in muscles of both sex was low. In all rabbits slaughtered in 1999, males and females, the contents of cadmium in kidneys were high (the highest rate was 21.1 ppm). In liver of 6 males and 7 females the contents were normal (0.1-0.5 ppm), while in liver of 4 males and 3 females were high (the highest rate was 2.19 ppm). The content in muscles of all rabbits, males and females, were low (the lowest rate was 0.005 ppm). The contents of cadmium as in collective as individual samples were high in kidneys , either normal or high in liver and low in muscles. The contents of studied heavy metals in compared sex looked to be similar.
Falandysz (1991) in his studies obtained similar results. He has analyzed tissues of rabbits raised on small scale family farms. He has found a high contents of cadmium in kidneys (53 mg/kg) and lead in liver (0,54 mg/kg). Simultaneously the content of cadmium and lead in muscle tissue was low (Falandysz J., 1987 and 1991).

CONCLUSIONS :

1. Kidneys are more liable organ for bio-accumulation than liver and muscles of each heavy metal, but especially of cadmium. Therefore kidneys and livers should not be recommended for human consumption, if the animals were raised in highly polluted regions.
2. The accumulation of each heavy metal in muscle was low. Therefore rabbit meat can be recommended for human consumption, even if the animals were raised in highly polluted regions.
3. In all tissues nickel accumulates in least of all.

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