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CONTENT OF MACRO- AND MICROELEMENTS IN MEAT OF MALE KIDS AND RAM LAMBS IN RELATION TO THEIR SLAUGHTER AGE

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Abstract

The aim of the experiment was to determine the content of some chemical elements in meat tissue in kids of the White Improved breed and in rams of the Polish Lowland breed. After weaning (60 days of life), the animals were fed all-mash CJ and meadow hay. The mixtures were produced from components originating from the Polish region called Podlasie. At the age of 1 month, all kids and rams were castrated using the blood method. They were slaughtered at the age of 90, 120, 150 and 180 days of life. Samples to analyse the chemical elements were taken from *longissimus dorsi* muscles. Concentrations of Pb, Cd, Zn, Mn, Fe and Mg were determined.

Generally, more Pb in meat tissue of kids than rams was found, and a significant difference (p=0.01) for the slaughter on the 120th day of life was proven. However, the content of Cd was larger (p=0.05 for 90, 120 and 150 days) in ram tissues (0.003-0.014 mg kg^{-1}) than in kids. It should be noticed that both in kid and ram meat tissues, the norms for Pb and Cd content, established by the Minister of Health and the European Committee, were not exceeded, which makes the meat suitable for consumers. The meat tissue of kids was richer in iron and poorer in zinc and copper than that of lambs, and the level of these elements decreased with the slaughter age. It was also observed that the iron content in meat tissue on the 180-day slaughter of animals was less than 17 mg kg^{-1}. More copper in meat tissue of rams and zinc in kids slaughtered at the age of 150 and 180 days were found. To sum up, intensive feeding applied to fatten kids and lambs did not affect the accumulation of chemical elements in meat, and especially that of heavy metals.

Key words: meat tissue, male kids, ram lambs, macroelements, heavy metals.

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ZAWARTOŒÆ MAKRO- I MIKROELEMENTÓW W MIÊSIE KOZIO£KÓW I TRYCZKÓW W ZALE¯NOŒCI OD ICH WIEKU UBOJU

Abstrakt

Celem badañ by³o okreœlenie zawartoœci wybranych pierwiastków w tkance miêœniowej kozio³ków rasy bia³ej uszlachetnionej i tryczków polskiej owcy nizinnej. Zwierzêta po odsadzeniu od matek (60 dni ¿ycia) ¿ywiono mieszank¹ pe³noporcjow¹ CJ oraz sianem ³¹kowym. Pasze wyprodukowano z komponentów pochodz¹cych z regionu Podlasia. W wieku ok. 1 miesi¹ca wszystkie kozio³ki tryczki wykastrowano metod¹ krwaw¹. Zwierzêta ubijano w wieku 90, 120, 150 i 180 dni ¿ycia. Próby do oznaczenia pierwiastków pobierano z *m. longissimus dorsi*. Oznaczono zawartoœæ: Pb, Cd, Zn, Cu, Mn, Fe i Mg.

W tkance miêœniowej kozio³ków stwierdzono wy¿sz¹ zawartoœæ Pb ni¿ u tryczków, a istotn¹ ($p \leq 0.01$) ró¿nicê stwierdzono w przypadku uboju w 120. dniu ¿ycia, natomiast zawartoœæ Cd by³a wy¿sza ($p \leq 0.05$) w przypadku 90., 120. i 150. dnia w tkankach tryczków (0.003-0.014 mg kg^{-1}) ni¿ kozio³ków. Nale¿y podkreœliæ, ¿e w tkance miêœniowej kozio³ków i tryczków nie zosta³y przekroczone normy zawartoœci Pb i Cd ustalone przez Ministra Zdrowia oraz Komisjê Europejsk¹, co czyni to miêso w pe³ni przydatne dla konsumenta. Analizowana tkanka miêsna koŸl¹t okaza³a siê bogatsza w ¿elazo i ubo¿sza w cynk i miedŸ ni¿ u jagni¹t, a poziom tych pierwiastków obni¿a³ siê wraz z wiekiem ubijanych zwierz¹t. Zaobserwowano, ¿e u zwierz¹t ubijanych w 180. dniu ¿ycia zawartoœæ Fe w tkance miêsnej u niektórych sztuk wynosi³a poni¿ej 17 mg kg^{-1}. Natomiast wy¿szy poziom miedzi stwierdzono w tkance miêœniowej tryczków, a cynku u kozio³ków ubijanych w wieku 150 i 180 dni ¿ycia. Zaobserwowano, ¿e zastosowane intensywne ¿ywienie w tuczu koŸl¹t i jagni¹t nie wp³ynê³o na kumulacjê pierwiastków, a szczególnie metali ciê¿kich w miêsie.

S³owa kluczowe: tkanka miêsna, kozio³ek, tryczek, makroelementy, metale ciê¿kie.

INTRODUCTION

Meat obtained from young kids has excellent quality and delicate taste. It is also rich in phosphorus, sulphur, copper, iron and calcium. This type of meat competes with veal and lamb as regards its nutritive value (LIDWIN-KA•MIERKIEWICZ 2006, NIEDZIÓ£KA et al. 2007). The world production of meat from lambs and goats is approximately 14 million tons (i.e. 4.9% of total meat quantity). Despite the fact that production of these two kinds of meat has increased by about 2.6 million tons, in some regions of the world, e.g. the EU, meat from lambs and kids remains in short supply (FAOSTAT 2008). Issues connected with contamination of the environment, feed or water pollution as well as accumulation of chemical elements in food products (meat) can reduce food export from countries of large soil, water or food pollution (WÊGLARZY 2007).

Studies conducted so far have often shown some differentiation of levels of elements in tissues and edible organs, from trace amounts to values exceeding physiological ones. The levels of chemical elements in animal tissues depend on species, gender, age and kind of tissue (ABOU DONIA 2008,

HOFFMAN et al. 2003, JOHNSON et al. 1995, KRUPA and KOGUT 2000, LIPECKA et al. 2003, PIENIAK-LENDZION et al. 2006).

The aim of the study was to define the content of some chemical elements in meat tissue of male kids and ram lambs fed all-mash and slaughtered at different age.

MATERIAL AND METHODS

Castrated male kids (n=24) of the White Improved breed and castrated ram lambs (n=24) of the Polish Lowland sheep breed fattened up to 90, 120, 150 and 180 days of life were used as the experimental material. Male kids and ram lambs were kept together with their mothers and drank mothers' milk until the 60th day of life. At the age of 1 month, all the kids and rams were castrated using the blood method. The experimental animals were fed *ad libitum* with dry mash CJ and meadow hay as a structural supplement. The mixtures were produced from components grown in Podlasie. Samples were taken from *longissimus dorsi* muscles. The content of chemical elements such as Zn, Cu, Mn, Fe was tested with an atomic absorption spectrophotometer AAS. The content of Pb and Cd was analysed using the extraction method. An atomic absorption spectrophotometer AAS-30 manufactured by Carl Zeiss Jena was used to conduct the analyses. Sample consisting of 10 g of material each were dried at the temperature 150^{o}C for 24 hours. Then, each sample was combusted in a muffle stove (temp. 420^{o}C). The ash was moistened with nitric acid and, after distilling with nitrogen oxide, it was placed back in the muffle stove at the temperature 420^{o}C for 30 minutes. The white rest was dissolved in muriatic acid (1 mol dm^{-3}) and analysed directly from the aqueous solution by aspirating to the flame of an atomic absorption spectrophotometer. The content of heavy metals in meat was tested in a laboratory at the Institute of Chemistry of the University of Podlasie.

The results were statistically described in tables showing mean values ($\bar{x}$) as well as the minimum and maximum for each trait (min-max). Significance of differences between means for the species were worked out according to Tukey's test. Statistical calculations were done using Statistica 6.0 PL.

RESULTS AND DISCUSSION

Heavy metals such as Pb, Cd, Cu, Hg and Zn are the most common food contaminants and the most dangerous ones for health. According to the Ordinance of the Minister of Health (2003), the maximum content of Cd in

meat tissue is 0.05, and Pb 0.10 mg kg^{-1}. However, according to the European Committee Recommendation (2006), the maximum level of Pb and Cd in food products are 0.10 and 0.05 mg kg^{-1}, respectively. Both Pb and Cd concentrations in the analysed meat tissue of kids and rams did not exceed the maximum permissible amounts. Generally, more Pb was found in meat tissue of kids than that of rams, and significant ($p \leq 0.01$) difference (by 0.012 mg kg^{-1}) for the slaughter on the 120th day of life was demonstrated. On the other hand, the Cd content was larger ($p \leq 0.05$ for 90, 120 and 150 day) in tissues of ram lambs (0.003-0.014 mg kg^{-1}) than in male kids (Table 1). Lower Cd and Pb concentrations in female and male kids which were slaughtered at 150 days of age were found in some previous research (Pieniak-Lendzion et al. 2006). However, a higher content in goats and sheep in the Rzeszow region, especially that of cadmium (above norms) was found by Krupa and Kogut (2000). Moreover, Kreełowska-Kułas (1998) paid attention to differences in the lead and cadmium content in meat of some animal species with regard to the level of environmental contamination. The author compared the cadmium and lead content in meat tissue of lambs from the Kraków region with the content of these metals in lamb meat from the Maków Podhalanski region. She noticed that the cadmium accumulation amounted to 0.01 and 0.002 mg kg^{-1}, and lead accumulation reached 0.089 and 0.007 mg kg^{-1}, respectively. In another study completed by Abou Donia (2008), the lead content in buffalo, cattle, sheep, goat and elk meat was studied with reference to some industrial, urban and communication areas. It was found that sheep and goats accumulated the least Pb in meat tissue and internal organs compared with the other species. The lowest content of

Table 1

Content of lead and cadmium in muscle tissue of male kids and ram lambs (mg kg^{-1} fresh tissue)

Elements	Age of slaughter	Animals' species			
		male kids		ram lambs	
	(days)	$\bar{x}$	min. - max.	$\bar{x}$	min. - max.
Pb	90	0.031	0.021 - 0.041	0.028	0.018 - 0.028
	120	0.036**	0.026 - 0.046	0.024**	0.004 - 0.041
	150	0.040	0.010 - 0.071	0.041	0.021 - 0.061
	180	0.041	0.021 - 0.061	0.047	0.007 - 0.087
Cd	90	0.001*	0.000 - 0.004	0.003*	0.002 - 0.004
	120	0.002*	0.001 - 0.006	0.005*	0.002 - 0.008
	150	0.004*	0.002 - 0.006	0.006*	0.004 - 0.008
	180	0.006	0.001 - 0.011	0.014	0.008 - 0.020

* values with different letters differ significantly ($p<0.05$) for the animal species
** as above for $p<0.01$

Pb in meat tissue of animals living close to transportation routes was found for sheep and goats (0.006 mg kg^{-1} for sheep and 0.009 mg kg^{-1} for goats). The highest level of Pb was determined in both meat tissue and giblets of animals inhabiting an industrial area. The content of chemical elements varied in relation to a lamb breed and sex, which was confirmed by HOFFMAN et al. (2003). The authors found that lambs of the Suffolk pure and crossbred race, which were slaughtered at 40 kg of body weight, were characterized by the largest level of Pb (0.048-0.064 mg kg^{-1}). LITWINCZUK et al. (2001) confirmed the results with regard to the metal content in cows and bulls. These authors concluded that that the Pb and Cd content in *longissimus dorsi* muscles was higher in cows than in bulls, being equal to 0.39 mg kg^{-1} of Pb and 0.083 mg kg^{-1} of Cd, with significant differences at $p \leq 0.05$.

Meat tissue of male kids was characterized by a bigger iron content ($p \leq 0.05$ at 90 and 120 days) than that of ram lambs. The content of this chemical element decreased together with the slaughter age from 41.67 to 23.73 mg kg^{-1} (Table 2). It was also observed that the element content in meat tissue of older animals fell below 17 mg kg^{-1}. A similar content (16.29--18.83 mg kg^{-1}) of iron in meat tissue of lambs slaughtered at 40 kg of body weight was found by HOFFMAN et al. (2003). Cadmium and copper could affect the iron accumulation and decrease its content in tissues (MORAWIEC 1991, WĘGLARZY 2007). Lower amounts of zinc and copper in the analysed meat tissue of male kids and ram lambs, regardless of the slaughter age, were found. Significantly ($p \leq 0.01$) more Cu and Zn in meat tissue of rams (150 days) was determined, i.e. 1.42 and 39.56 mg kg^{-1}, respectively (Table 2). Similar amounts of Cu and Zn in *m. semimembranosus* of lambs were discovered by HOFFMAN et al. (2003). The content of Zn ranged from 27.86 to 54.66 mg kg^{-1}, and the Cu content varied from 0.87 to 1.40 mg kg^{-1}. The level of the chemical elements strongly depends on a breed and genotype. In the research presented by PIENIAK-LENDZION et al. (2006), gender had an effect on the Zn and Cu content. Female kids slaughtered at the age of 150 days were characterized by a 0.29 mg kg^{-1} higher Cu content and male kids had 0.52 mg kg^{-1} more Zn by ($p \leq 0.05$). JOHNSON et al. (1995) obtained on average 28.1 mg 100 g^{-1} of calcium, 92.3 mg 100 g^{-1} of zinc and 4.4 mg 100 g^{-1} of iron in meat tissue of kids. In an experiment reported by LIPECKA et al. (2003), the effect of a feeding system on the content of chemical elements in meat tissue of lambs slaughtered at 25-30 kg of body weight was tested. Non-significant differences for the content of Pb, Cd, Cu and Zn in meat tissue of lambs fattened intensively and on pasture were revealed. The differences between the groups were only noticed with regard to magnesium, which appeared in higher quantities in lambs fattened with concentrates (317.30 mg kg^{-1}) than in those pastured (281.44 mg kg^{-1}). In the present study, a lower average content of Mg was found, which in meat tissue of lambs ranged from 262.54 to 295.95 mg kg^{-1} (Table 2). Moreover, a significantly larger content of this chemical element was found in meat tissue of male kids than in that of ram lambs aged 90 and 150 days.

Table 2

Content of copper, zinc, manganese, iron and magnesium in muscle tissue of male kids and ram lambs (mg kg^{-1} fresh tissue)

Elements	Age of slaughter	Animals' species			
		male kids		ram lambs	
	(days)	$\bar{x}$	min. - max.	$\bar{x}$	min. - max.
Cu	90	0.94	0.74 - 1.18	1.08	0.87 - 1.29
	120	1.12	0.85 - 1.39	1.17	0.96 - 1.40
	150	1.32**	0.98 - 1.66	1.42**	0.86 - 1.98
	180	2.28	1.61 - 2.95	2.41	2.02 - 2.80
Zn	90	29.12	24.58 - 33.66	29.56	26.14 - 32.98
	120	29.43	26.19 - 32.67	31.87	28.66 - 35.08
	150	33.26**	29.37 - 37.15	39.56**	36.90 - 42.22
	180	51.71	49.15 - 54.27	49.41	45.94 - 52.88
Mn	90	0.46**	0.40 - 0.52	0.38**	0.31 - 0.45
	120	0.34	0.25 - 0.43	0.33	0.24 - 0.42
	150	0.30	0.23 - 0.37	0.32	0.28 - 0.36
	180	0.30**	0.22 - 0.38	0.40**	0.35 - 0.45
Fe	90	41.67*	34.80 - 48.54	24.89*	18.11 - 31.67
	120	38.22*	32.90 - 43.54	27.62*	21.62 - 33.62
	150	29.14	25.69 - 32.59	27.15	21.48 - 32.82
	180	23.73	16.84 - 30.62	23.89	16.68 - 31.11
Mg	90	295.32*	228.62-362.02	262.54*	219.33-307.75
	120	314.89	259.22-370.56	303.78	269.24-338.32
	150	289.23*	243.56-334.90	269.73*	215.08-324.38
	180	292.56	228.56-356.56	295.95	230.86-361.04

* values with different letters differ significantly ($p<0.05$) for the animal species
** as above for $p<0.01$

CONCLUSIONS

1. Low content of lead and cadmium in meat tissue was found in the course of intensive fattening of kids and rams. Meat tissue in kids compared with rams contained more lead and less cadmium. The levels of the heavy metals in meat did not exceed the maximum permissible amounts, i.e. 0.10 mg kg^{-1} of Pb and 0.05 mg kg^{-1} of Cd.

2. Kid meat was characterized by a larger content of Fe (41.67-23.73 mg kg^{-1}) than ram meat (24.89-23.89 mg kg^{-1}). The content of chemical elements decreased with the slaughter age, which was caused by a larger content of Cu in mixtures, which in turn could have affected the iron level in animal bodies.

3. The fattening period ended in a larger accumulation of Cu and Zn especially. More Cu in meat tissue of rams and Zn in kids slaughtered at the age of 150 and 180 days were found.

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