tvar 24,87±0,04%, voda 75,13±0,04%, bjelančevine 20,66±0,05%, mast (ekstrakt etera) 3,12±0,06% i pepeo 1,10±0,002%. Izračunali smo fenotipske korelacije između kemijskih komponenti te analizirali razne utjecaje za sve komponente. Svi izračuni su rađeni u SAS 8.0 (Sustav statističke analize) i Statistika 7.1. Fenotipske korelacije između suhe tvari i vode, bjelančevina, masti i pepela iznosile su–1,000, 0,159, 0,533 odnosno –0,164. Korelacije između vode i bjelančevina, masti i pepela bile su –0,159, -0,533 odnosno 0,164. Koeficijent korelacije između bjelančevina i masti bio je –0,750, između bjelančevina i pepela –0,026 a između masti i pepela –0,113. Svaka je korelacija bila značajna (P<0,01), uz iznimku korelacije između bjelančevina i pepela. Utjecaj godine, godišnjeg doba, mjeseca i bika na kemijski sastav MLD bio je značajan (P < 0,001).

Procjene fenotipske korelacije pokazuju da bi se ispitivane karakteristike mogle koristiti za selekciju bikova za UO.

***Ključne riječi:** Simentalska goveda, meso, kemijski sastav, fenotipska korelacija*

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OCCURRENCE OF SELECTED TRACE ELEMENTS IN CATTLE MEAT

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SUMMARY

The occurrence of trace metals (Cu, Zn) was determined in cattle meat from the vicinity of a metallurgical plant. Copper and zinc concentrations in 62 samples of muscles and liver collected from (31) cows were quantified and compared with results in other countries. In our study

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mean muscle Zn and Cu concentrations were higher in liver (67.314; 44.205 mg/kg w. wt) compared to muscle (38.865; 1.993 mg/kg w. wt). It can be concluded that bioaccumulation of Zn and Cu in cattle meat in industrial areas could be slightly enhanced, differently in dependence on the types of industry prevailing in various countries.

Key words: *Cu, Zn, cattle meat, and liver*

INTRODUCTION

Pollution of environment by emissions within large industrial centres has become a serious problem in a lot of countries (Miranda et al., 2005; Kimáková and Bernasovská, 2006). The structure of these emissions depends greatly on the structure of industry (Kolacz et al., 1996; Beňová et al., 2007). Industrial uses of metal and agricultural activities have now led to a widespread dispersion of this metal at trace levels into the natural environment and in human foodstuffs (Satarug et al., 2000; Kočišová et al., 2006).

Cattle production is one of the most important forms of agriculture in Slovakia and beef meat is an important part of the human diet. Cattle are predominantly fed on locally grown fodder and are the primary livestock species exposed to metal contamination. The farm animals such as sheep and cattle, reared freely, on pasture are the indicators of environmental pollution. Trace elements bioaccumulate in tissues of animals by respiration of polluted air and intake of contaminated feed (Tahvonen, 1996). The impact of minerals such as zinc (Zn) and copper (Cu) on growing cattle is well known. These minerals are needed in sufficient quantities to promote health and to optimise production and reproduction (Ward and Spears, 1997). Cu and Zn are necessary for the animal life but they may be toxic and harmful at high level of exposure (Solyak et al., 2001; Turgoklu et al., 2004). The aim of the study was to determine the effects of industrial emissions on the levels of Cu and Zn in meat of cattle.

MATERIALS AND METHODS

Muscle and liver samples (n = 62) of 31 cattle (of mean age of 3 to 5 years) have been taken from the vicinity of a metallurgical plant in order to detect the content of Cu and Zn. The samples of cattle tissue were immediately frozen and stored at -20 °C until analysis. The analysis consisted of digestion (5 ml HNO_3 and 1 ml HCl per 1 g of sample) in the microwave oven Milestone and determination of heavy metal by the method of Kocourek (1992). Reproducibility of the method was tested by analysis of the reference materials (MBH ANAL Ltd., England). Samples of meat were analysed for the presence of Cu and Zn using an atomic absorption spectrophotometer (AAS; Unicam Solar 939, UK), with a graphite furnace with background correction. The flame conditions and graphite furnace were optimised for maximum absorbency and linear response while aspirating known standards. The standards were prepared from the individual 1000 mg.kg-1 standard (Merck, Germany); 100 ml of five combined standards were prepared in 0.1 N HNO_3. The lamp current used was 75%. The signal type was continuous for Cu and Zn. Measurement time was 3 seconds. The recovery methods were 96-98% and reproducibility was better than 1.0%. All metal concentrations are expressed on a wet weight (w. wt). Data are presented as mean, maximum and standard deviation (Sd).

RESULTS AND DISCUSSION

The occurrence of foreign substances in foods of animal origin is systematically monitored from both the veterinary and human medicine point of view (Kožárová, 2004). Zn and Cu concentrations in cattle meat have been little studied in comparison with these foreign substances. Although the trace metal content in muscle is generally low, offals, such as liver often accumulates higher metal concentrations (Massanyi et al., 2005).

The results of this study confirmed lower mean Zn concentrations in muscles than in liver of cattle (38.865; 67.314 mg/kg w. wt). Our findings (Table 1) were compared with results of Lopez-Alonso, et al., (2000), obtained in cattle in an industrial area in Spain (Galicia). They observed higher Zn concentrations in the muscles (52.7 mg/kg w. wt) and slightly lower concentrations in the liver (59.8 mg/kg w. wt) of cattle. The results of both studies showed that the liver is the main organ of accumulation of Zn.

Farmer and Farmer, (2000) have analysed animal and meat (cattle, horse and sheep) products in a metal processing region in east Kazakhstan. Samples were collected from various districts at different distances from the main source of anthropogenic pollution. Analyses for Zn revealed high concentrations in many feed and meat samples. Horse samples had higher levels of contamination than cattle, which were higher than in sheep.

In our study, mean concentrations of Cu were higher in the liver (44.205 mg/kg w. wt) compared to muscles (1.993 mg/kg w. wt) of cattle. Our results from metallurgical polluted area were compared with results obtained from the industrial area in Spain (Lopez-Alonso et al., 2000). The results of Cu concentrations in muscles and liver (1.26; 60.3 mg/kg w. wt) were broadly similar to those recorded in Slovakia. Only copper levels in the liver were high.

According to Benemariya et al.,(1993), Cu accumulates mainly in the liver. Ruminants have a superior capacity to bind Cu in the liver and have relatively poor Cu excretion. The characteristic of high Cu storage capacity in ruminants means that they are likely to be good bio-monitors of environmental Cu levels and can be used for identification of areas of Cu contamination.

Cu and Zn concentrations in liver samples of dairy cows in Southern Turkey were quantified by Erdogan et al. (2004). Samples were collected from an iron-steel processing region and an area free of industrial pollution. The liver Cu levels in samples taken from the industrial region in winter were higher compared to samples collected from the unpolluted region. Zinc levels in the liver were not found to differ among the regions in both seasons. Cu concentrations were below the critical level in 32% of liver samples analysed in this study. The majority of liver samples had lower amounts of Zn. Although slight differences were observed between the industrial and non-industrial regions, the industrial activities and seasonal changes had no significant effect on selected element concentrations on cows and their milk.

From the above-mentioned results it can be concluded that the content of these metals should be monitored. It seems that types of industry that are prevalent in various countries or industrial areas and level of industrialisation could differently enhance bioaccumulation of Cu and Zn in cattle meat. These elements prove to be environmental factors in the vicinity of the centres of metallurgical production from the viewpoint of potential impact on public health.

Table 1. Concentration of zinc and copper in the muscle and liver of cattle (mg/kg w. wt.) in Slovakia

Tablica 1. Koncentracija cinka i bakra u mišićima i jetri goveda (mg/kg) u Slovačkoj

	Zinc (mg/kg) Cink (mg/kg)		Copper (mg/kg) Bakar (mg/kg)	
	Muscle/mišićje	Liver/jetra	Muscle/mišićje	Liver/jetra
n	31	31	31	31
x	38.865	67.314	1.993	44.205
x max	61.599	114.032	3.346	76.416
Sd	16.520	32.068	1.146	28.584

n - number of samples analysed / broj analiziranih uzoraka;
x - arithmetic mean / aritmetička sredina; x max - maximal values / maksimalne vrijednosti; Sd - standard deviation /standardna devijacija

SAŽETAK

POJAVA ELEMENATA U TRAGOVIMA U GOVEĐEM MESU

Pojava elemenata u tragovima (Cu, Zn) određivana je u mesu goveda uzgajanih u blizini metalurškog postrojenja. Koncentracije bakra i cinka u 62 uzorka mišića i jetre uzetih od 31 krave kvantificirane su i uspoređene s rezultatima iz drugih zemalja. U našem su ispitivanju koncentracije Cu i Zn bile više u jetri (67,314; 44,205 mg/kg v. t.) od onih u mišićju (38,865; 1,993 mg/kg v. t.). Može se zaključiti da bi bioakumulacija Zn i Cu u mesu goveda mogla biti nešto povećana i različita ovisno o vrsti industrije koja prevladava u raznim zemljama.

Ključne riječi: *Cu, Zn, goveđe meso, jetra*

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KEMIJSKI SASTAV MESA MOŠUSNIH PATAKA (*CAIRINA MOSCHATA*) IZ EKSTENZIVNOG UZGOJA – PRELIMINARNI REZULTATI

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SAŽETAK

Uzorci mesa bataka i prsa četiri mošusne patke, dvije ženke i dva mužjaka, podrijetlom iz ekstenzivnog uzgoja podvrgnuti su kemijskim analizama. U prosjeku količina masti u pretraženim uzorcima iznosila je 2,37 %, količina proteina 20,47 %, a količina vode 72,93 %. Dobiveni rezultati ukazuju na podjednak kemijski sastav mesa i bataka i prsa, uz naročito nizak udio masti. S obzirom

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