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Comparison of essential metals in different pork meat cuts from the Serbian market

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Abstract

Pork consumption in Serbia accounts for a large share of total meat consumption. Pork is valuable sources of nutrients. We analyzed metal content in three different cuts of pork collected from the Serbian market during 2014. Analyses of the following isotopes: zinc (^{66}Zn), copper (^{63}Cu) and iron (^{57}Fe) were performed by ICP-MS. Our data show that Zn, Cu and Fe were present in significantly different levels in hind leg, loin and shoulder, and that shoulder meat was richest in the analyzed metals. The differing mineral status of different pork cuts implies differences in their nutritional benefits for the human diet.

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Keywords: pork; zinc; copper; iron; ICP-MS

1. Introduction

A proper diet is essential for optimal human growth and development. Meat is one of the most valuable sources of nutrients and ensures the adequate delivery of essential micronutrients and amino acids[1,2,3,4]. Several micronutrients are exclusively present in meat, or their bioavailability in meat is much higher than in other

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sources[1,5,6]. In the total diet, meat is the one of the richest sources of zinc, while it also provides sufficient amounts of copper[7,8]. Zinc deficiency in diets causes problems such as depression[9,10] and accumulation of cadmium, a toxic element, in some human tissues and organs[11]. On the other hand, high amounts of zinc in food can be harmful to human health[12]. Copper is also essential for a number of biochemical processes; however, a high content in food could cause health problems[12]. Bioavailability of iron is greatest when it is in the heme form, and meat is the primary source of this form[13,14]. Iron functions primarily as a carrier of oxygen in the body, both as a part of hemoglobin in the blood and of myoglobin in the muscles, and iron deficiency in food may cause anemia.

Over the last decades, rapid growth in livestock production has been driven by an increasing demand for animal-sourced foods, and developing countries accounted for the main share of this increase[15,16]. According to FAO data for 2008, in Serbia, pork consumption accounted for the highest share of total meat consumption (49.0%), followed by poultry (35.3%) and beef (15.7%)[17].

In respect of the large impact of proper meat quality to the human diet, together with the high consumption of pork in Serbia, the aim of the current study was to determine the content of the essential metal elements (Zn, Cu and Fe) in pork. Furthermore, the amounts of these elements analyzed in different pig meat cuts (hind leg, loin and shoulder) were compared by statistical analysis.

2. Materials and methods

The content of zinc, copper and iron were measured from 60 pork samples (hind leg n = 20, loin n = 20, shoulder n = 20). Analyzed meat samples were taken from the Serbian market during 2014. Pork samples were individually stored in plastic bags at -18ºC prior to analysis.

Frozen pork samples were homogenized in a commercial blender (Bosch, MMR501). Aliquots of approximately 0.3 g were transferred into teflon vessels and treated with 5 ml nitric acid (67% Trace Metal Grade, Fisher Scientific, Bishop, UK) and 1.5 ml hydrogen peroxide (30% analytical grade, Sigma-Aldrich, St. Louis, MA, USA). Sample homogenates were further digested in a microwave (Start D, Milestone, Sorisole, Italy) according to the following regime: 5 min from room temperature to 180°C, 10 min hold 180°C, and 20 min vent. Digested homogenates were quantitatively transferred into volumetric flasks and diluted to 100 ml with deionized water (ELGA, Buckinghamshire, UK).

Analyses of isotopes of zinc (^{66}Zn), copper (^{63}Cu) and iron (^{57}Fe) were performed by inductively coupled plasma assisted mass spectrometry (ICP-MS) "iCap Q" (Thermo Scientific, Bremen, Germany), equipped with a collision cell, and operating in the kinetic energy discrimination (KED) mode. To optimize mechanical and electrical parameters and minimize probable interferences, torch position, ion optics and detector settings were re-adjusted daily using tuning solution (Thermo Scientific Tune B). A five-point calibration curve (including zero) was constructed for each isotope (^{66}Zn, ^{63}Cu and ^{57}Fe), in the concentration range of 0.1–2.0 mg/l. Multielemental internal standard (^{6}Li, ^{45}Sc-10 ng/ml; ^{71}Ga, ^{89}Y, ^{209}Bi-2 ng/ml) was introduced online by another line of the peristaltic pump. Measured concentrations were corrected for the response factors of internal standards. The quality of the analytical process was confirmed by the analysis of the standard reference materials SRM 1577c and SRM 2384 (Gaithersburg, MD, USA), and were within the range of the certified values.

Statistical analysis of obtained data was performed using the Minitab 16.0 software. One-way (unstacked) ANOVA analysis of variance and Tukey'spost hoc test was used in order to compare the mean content of Zn, Cu and Fe between pork samples of hind leg, loin and shoulder.

3. Results and discussion

Contents of Zn, Cu and Fe measured in analysed pork hind leg, loin and shoulder, expressed as a mean values ± standard deviation, plus ranges, are presented in Table 1.

The highest levels of Zn were quantified in pig shoulder (22.6 mg/kg) compared to the significantly lower levels present in hind leg (15.8 mg/kg) and loin (15.2 mg/kg). Similarly, levels of Cu (0.8 mg/kg) were also significantly higher in shoulder, compared to hind leg (0.6 mg/kg) and loin (0.5 mg/kg). Unlike Zn and Cu, levels of Fe were highest in the shoulder (7.6 mg/kg), which was similar to levels observed in hind leg (6.5 mg/kg), but both were significantly higher than Fe concentrations in loin (3.8 mg/kg). Thus, it appears that pig shoulder is richest in Zn, Cu and Fe and levels are significantly higher than in pig loin, where the lowest levels of Zn, Cu and Fe were detected. Furthermore, from all analyzed metals, levels of Zn were by far highest, followed by the Fe, and Cu.

Table 1.Content of Zn, Cu and Fe (mg/kg) in pork samples of hind leg, loin and shoulder.

Pork meat	*n*	Mean ± SD(ranges)		
		Zn	Cu	Fe
Ham	20	15.8 ± 2.1^{b} (12.4-19.4)	$0.6 \pm 0.3^{a,b}$ (0.2-1.3)	6.5 ± 1.8^{a} (3.9-9.9)
Loin	20	15.2 ± 2.8^{b} (10.6-18.9)	0.5 ± 0.3^{b} (0.1-1.2)	3.8 ± 1.3^{b} (1.4-6.7)
Shoulder	20	22.6 ± 8.2^{a} (11.2-39.5)	0.8 ± 0.2^{a} (0.2-1.2)	7.6 ± 1.8^{a} (4.0-9.7)

^{a,b}*Values within the same column with different superscripts (a,b) are significantly different ($p < 0.05$).*

To the best of our knowledge, most of the available literature data shows the average levels of metals in pig meat, without specifying the animal muscle analyzed. Bilandzic *et al.*[18] reported levels of Fe (6.33 mg/kg) and Zn (22.2 mg/kg) from the pork to be in the same concentration range as levels reported in this study. Similarly, Lopes-Alonso *et al.*[19] reported levels Cu, Zn and Fe in pig muscle to be 6.85, 42.5 and 26.5 mg/kg, respectively. Although levels of Cu in Galician pigs were comparable to pigs from the Serbian market, levels of Zn and Fe were several times higher than their levels in pigs analysed in this work. Though authors do not specify the muscle type used for the analysis, such high differences may arise from the different diets during animal growth and different breed of pigs. In fact, Ren *et al.*[20] showed that the levels of Zn, Cu and Fe significantly vary between five different pig breeds.

Recently, Tomovic *et al.*[21] analyzed content of metals in semimembranosus muscle (hind leg) from pigs from 10 different genetic lines, produced in Vojvodina. They showed slightly higher levels of Zn (27.4 mg/kg) compared to our findings, while levels of Cu (3.5 mg/kg) and Fe (14.6 mg/kg) were more than two times higher compared to the observed levels in the pig ham of this study.

Relatively few authors have looked for metal content in different pig muscles. For the purpose of the present study, we collected samples from the Serbian market, regardless of pig breed. This work showed that regardless of the breed pig, metal concentrations vary significantly between hind leg, loin and shoulder of pig.

4. Conclusion

Concentrations of Zn, Cu and Fe were significantly different in the analysed hind leg, loin and shoulder meat. Shoulder was the richest in all analyzed metals. While most other authors have reported the overall metal levels quantified from pig muscle, this work emphasises the importance of the separate analysis of different muscle types, or different cuts – in this case, shoulder, hind leg and loin. The differing mineral status of various pork cuts implies differences in their nutritional benefits for the human diet.

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References

1. Nohr D, Biesalski HK. 'Mealthy' food: meat as a healthy and valuable source of micronutrients. *Animal* 2007;**1**:309–16.
2. Melo R, Gellein K, Evje L, Syversen T. Minerals and trace elements in commercial infant food. *Food Chem Toxicol* 2008;**46**:3339–42.
3. Skobrák EB, Károly B, Mikóné Jónás E, Gundel J, Jávor A. The Comparison Analysis of the Main Chemical Composition Parameters of Wild Boar Meat and Pork. *J Anim Sci Biotechnol* 2011;**44 (1)**:27–31.
4. Tatulov J, Sus I, Miteljstejn T. Kvalitet delova dobijenih rasecanjem svinjskih trupova. *Tehn mesa* 2010;**51**(1):71-6.
5. Biesalski HK, Nohr D. The nutritional quality of meat. In: Kerry JP, Ledward D, editors. *Improving the sensory and nutritional quality of fresh*

meat, 1st ed. Cambridge, England: Woodhead Publishing Ltd; 2009.
6. Troy DJ, Kerry JP. Consumer perception and the role of science in the meat industry. *Meat Sci* 2010;**86**:214–26.
7. Ikem A, Egiebor NO. Assessment of trace elements in canned fishes (mackerel, tuna, salmon, sardines and herrings) marketed in Georgia and Alabama (United States of America). *J Food Comp Anal* 2006;**18**:771-87.
8. Lombardi-Boccia G, Lanzi S, Aguzzi A. Aspects of meat quality: Trace elements and B vitamins in raw and cooked meats. *J Food Comp Anal* 2005;**18**:39-46.
9. McLoughlin IJ, Hodge JS. Zinc in depressive disorder. *Acta Psychiat Scand* 1990;**82**:451-53.
10. Maes M, Vandoolaeghe E, Neels H, Demedts P, Wauters A, Meltzer HY, Altamura C, Desnyder R. Lower serum zinc in major depression is a sensitive marker of treatment resistance and of the immune/inflammatory response in that illness. *Biol Psychiatry* 1997;**42**:349–58.
11. Brzóska MM,Moniuszko-Jakoniuk J. Interactions between cadmium and zinc in the organism. *Food Chem Toxicol* 2001;**39**:967–80.
12. Agency for toxic substances & Disease registry, 2005. Department of health and human services. Public Health Statement for Copper.
13. Carpenter CE, Mahoney A. Contributions of heme and nonheme iron to human nutrition. *Crit Rev Food Sci Nutr*1992;**31**:333-67.
14. Lombardi-Boccia G, Martinez Dominguez B, Aguzzi A. Total, heme, non-heme iron in raw and cooked meats. *J Food Sci* 2002;**67**:1738-41.
15. Delgado C, Rosegrant M, Steinfeld H, Ehui S, Courbois C. Livestock to 2020 the next food revolution, in Food, Agriculture and the Environment Discussion, International Food Policy Research Institute.
16. Food and Agriculture Organization of the United Nations and International Livestock Research Institute,Washington, DC, USA, 1999.
17. Food and Agriculture Organization of United Nations 2008;www.fao.org
18. Bilandzic N, Sedak M, Djokic M, Varenina I, Solomun Kolanovic B, Bozic Dj, Brstilo M, Sokolic-Mihalak D, Jurkovic Z. Comparative study of iron, magnesium and zinc and daily intakes in certain meats and meat products. *Slov Vet Res* 2013;**50(3)**:103-10.
19. Lopez-Alonso M, Miranda M, Castillo C, Hernandez J, Garcia Vaquero M, Benedito JL. Toxic and essential metals in liver, kidney and muscle of pigs at slaughter in Galicia, north-west Spain. *Food Addit Contam* 2007;**24(9)**:943–54.
20. Guang-zhi R, Ming W, Zhen-tian L, Xin-jian L, Jun-feng C, Qing-Qiang Y. Study on the Correlations between Mineral Contents in Musculus Longissimus Dorsi and Meat Quality for Five Breeds of Pigs. *Am J Anim Vet Sci* 2008;**3(1)**:18-22.
21. Tomovic V, Petrovic Lj, Tomovic M, Kevresan Z, Dzinic N. Determination of mineral contents of semimembranosus muscle and liver from pure and crossbred pigs in Vojvodina (northern Serbia). *Food Chem* 2011;**124**:342–48.