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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 (⁶⁶Zn), copper (⁶³Cu) and iron (⁵⁷Fe) 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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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 organs¹¹. On the other hand, high amounts of zinc in food can be harmful to human health¹². Copper is also essential for a number of biochemical processes; however, a high content in food could cause health problems¹². 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 -18°C 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 (^6Li , ^{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's post 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 \pm 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

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