HEAVY METAL CONTAMINATION OPOF WILD BOAR MEAT (*SUS SCROFA*)

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Abstract

Wild boar meat brings an important nutritional intake for the consumer. The chemical composition of game meat is an important parameter and can be a desideratum to use this meat for the purpose of diversifying the products. The wild boar (Sus Scrofa) is part of the family Suidae. In order to ensure a high degree of harmlessness, it is important to observe the rules of hygiene for establishments storing or processing game carcasses, including premises, equipment, utensils and staff. The purpose of this study was to determine the physico-chemical composition and the content of heavy metals in wild boar meat.

Keywords: heavy metals, fat, protein, wild boar, meat

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INTRODUCTION

Meat consumption has many benefits, such as energy, eliminating skin diseases, strengthening the immune system, tissue repair and protecting the body against infection (Segal, 2002). Studies show lead and cadmium concentrations in pork may pose high risks to human health. In some cases, the concentrations of these metals exceed the legislation or Codex Alimentarius limits (Arafa et al., 2014). Heavy metals can lead to large imbalances in the animal and human body (Laslo et al. 2000).

Sarcoplasmic proteins play a very important role in the biochemical transformations that take place in the muscle immediately after the slaughter of the animals, in determining some sensory characteristics of meat, like smell, taste and color, having a reduced role in determining the texture of the meat (Țibulcă and Sălăgean, 2000). Hunting appeared as a human occupation in the Paleolithic era. Before man bred animals and cultivated plants, hunting was the main means of subsistence. For some peoples, hunting is even nowadays a practice of great importance (Cotta, 1982). Game includes all species of animals with fur or feathers, whose meat is accepted for human consumption, from hunting parties (Almășan, 1998). Game meat can be consumed if it complies with veterinary health regulations.

The physico-chemical properties of game meat determine a higher dietary value than the meat of some farm animals (Lenti et al., 2021). Accumulation of toxic substances is very low or almost non-existent (Banu, 2005). Meat harvested from wild animals has certain specific sensory characteristics regarding to smell and taste as well as developed fibrous tissue, which requires specific technological operations (Țibulcă and Sălăgean, 2000). The darker colour of game meat differs according to the intensity of muscle activity and the amount of retained blood (Bud et al., 2002).

Quality of wild boar meat

The quality of wild boar meat differs and depends largely on the feed ingested during the fattening period. Wild boar meat, compared to that from domestic pigs, is richer in protein, less rich in lipids and richer in mineral salts (Bodea, 1967, Lenti et al., 2021). Meat from wild boar is valued both in terms of nutritional and sensory qualities such as intense and sweet taste and nutty aroma (Guzek et al., 2013). Wild boar can present numerous infectious and parasitic diseases, which require examination of the carcass also in this regard (Bodea M., 1967). The purpose of this work was to evaluate the physico-chemical composition and the level of Pb and Cd in the boar meat.

Characterization of the wild boar (*Sus scrofa*)

The wild boar is part of the Suidae family. They are wild, aggressive animals, spread on all of the continents. The physiological longevity of the wild boar cannot be precisely estimated, although literature states a lifespan of maximum 20 years. Resulting the observation made it has been found that only 2,5% of the total live to be over 10 years. We can also attribute this percentage to the hunting of the specimens over 60 kg (Cotta, 1982, Șelaru, 1995). The skin, an integumentary, resistant formation, makes up about 16% of the weight of the living boar.

The color of the boar's skin varies from reddish-gray to blue. Its thickness is not uniform, becoming thinner from the spine , to the head and flanks, then to the outer part of the legs, the thinnest being on the belly.

Starting from the age of 3rd year, a thickening of the skin occurs on the outer parts of the chest, known as thoracic armor, through the development of a layer of skin at the expense of the fat layer (Bud et al., 2002). The muscles, along with the bones, make up the locomotor system of the boar. The most developed muscles are the thigh muscles, including the shoulder, neck and back muscles. They also include the muscle groups responsible for multiple and intense activity.

The gutting usually takes place right after the animal has been shot, to avoid muscular stiffening and disruption of generation of substances that may imprint an undesirable scent to the muscles (Ruth I., 2004). The washing of the carcass involves the removal of hematomas and of the gunshot wound, to prevent bacterial growth. Sectioning of the big veins is recommended for facilitating a better blood drainage and making ventilating incisions that partially divide the shoulder blade from the ribs (Almășan, 1998). Drying and cooling of the meat is carried out differently, depending on its type. After cooling, brushing of the carcass exterior and another wiping of the interior with dry cloths is performed. Wiping or washing the carcass with wet cloths will modify the aspect of the meat by blackening it (Ţibulcă and Sălăgean, 2000). Bulk transportation of the meat favours the fermentation process (acidic fermentation) of the meat, followed by the outer green decay. The meat can be identified when in the acidic fermentation phase by the following characteristics: the hairs can be pulled out easily, the skin is discoloured, and the surface of the muscles have a coppery-red colour (Ţibulcă and Sălăgean, 2000).

The yield varies depending on the season of the hunt, the age and the sex of the boar, it being 55% in the Summer and 65% in the Winter (Cotta, 1982; Bud, 2002).

Taking into consideration the possibility of fast meat decay, resulting from incomplete blood drainage, the large microbial load it has and the uncontrollable temperature, the conditioning of the meat starts right at the hunting place and it entails: gutting, drying, cooling, transporting, freezing and butchering of the carcass (Comisia A.M., 1982).

After the animal had been shot, the game meat, in general, undergoes the same physico-chemical and microbiological modifications as the domesticated animal meat. When the game meat is still fairly fresh the hairs and the skin are very difficult to remove. The muscle mass has a dark red section surface, an elastic consistency and an acidic reaction (pH = 6 – 6,4) (Stănescu and Savu, 1992).

MATERIAL AND METHOD

Atomic absorption spectrophotometry was used for the determination of the heavy metals. This method is based on the determination of the concentration of the chemical elements in the samples to be analysed by measuring the absorption of electromagnetic radiation of a specific wavelength as it passes through the medium in which the free atoms of the element in question are uniformly distributed. The absorption level is proportional to the concentration of atoms in the distribution medium.

Reagents needed for testing: High purity water (ultrapure with Total Organic Carbon (TOC) of 2 ppb). Stored only in tightly closed plastic containers. Pb standard solution c= 1000 mg/l (in HNO_3 0.5 mol/l.

Cd standard solution c= 1000 mg/l (in HNO_3 0.5 mol/l. Hydrochloric acid minimum 37 % mass fraction, from which hydrochloric acid solution 6 mol/l is prepared as follows: 500 ml hydrochloric acid is made up to the mark with ultrapure water in 1000 ml volumetric flask. Nitric acid, minimum 65% mass fraction from which 0.1mol/l nitric acid solution is prepared as follows: dilute 7 ml concentrated nitric acid with water to 1000 ml.

Standard solutions for the elements: Lead (Pb), Cadmium (Cd), are prepared from the concentrated solutions (1000 mg/l). From the Lead (Pb) solution we measured a volume of 1.0 ml and added to it 0.2% nitric acid solution up to 100 ml in the volumetric flask and mixed it thoroughly. This is the stock solution containing 10 microgram/ml (10 ppm). The solution can be stored for three months. A volume of 0.1 ml is measured from the Cadmium (Cd) solution, then 0.2% nitric acid solution is added up to 100 ml in a volumetric flask and mixed thoroughly. This is the stock solution containing 1.0 microgram/ml (1 ppm).

The calibration curve is drawn and the concentration of the element on the curve is read. The content is calculated, w, as a mass fraction of the element that is to be determined, in milligrams per kilogram of sample, using the following formula: w- the concentration in the sample, measured in milligrams per kilograms (mg/kg), a- the concentration of the element determined in the sample solution, measured in micrograms per liter (μg/l) , V- final volume of the sample solution, measured in milliliters (ml), F- dilution factor and m- mass of the sample measured in grams (g).

Depending on the mass of the sample, the final volume of the mineralisation or the dilutions made, the instrument software processes these data and displays the result directly. The following samples were used for analysis: wild boar meat, wild boar bacon, sausages, salami and wild boar ham. A total of 10 samples per category were analysed. The following elements were analysed: Cu, Pb, Cd and Zn (mg/ kg-1w. w).

RESULTS AND DISCUSSIONS

Young wild boar meat is harder to digest, for that reason consuming adult wild boar meat is recommended (Bârzoi, 1985). A particularity of the biochemical processes in the boar meat are the connective tissue proteins, which have a high degree of densification and polymerization, myofibrillar proteins being abundantly represented. The proteins in wild boar meat are resistant to enzymatic denaturation, therefore meat maturation is difficult (Banu, 2002). Also to ensure a high degree of harmlessness, it is important to respect the hygiene rules of the establishments where game carcasses are stored, processed or kept, including premises, machinery, utensils and staff (Banu, 1993).

In figure 1 and 2 are showed the average content of Cooper (Cu), Lead (Pb), Cadmium (Cd) and Zinc (Zn) present in wild boar meat and bacon, sausages, salami and ham.

Copper (Cu) content varied in the range (0.016 mg/ kg^{-1}) in wild boar salami and (0.026 mg/ kg^{-1}) in wild boar bacon (figure 1) .

Lead (Pb) carried the lowest values in wild boar meat (0.004 mg/kg^{-1}) and bacon (0.005 mg/ kg^{-1}). The highest values were in wild boar sausage (0.011 mg/kg^{-1}) and (0.009 mg/ kg-1) in wild boar salami (figure 1).

Cadmium (cd) showed average values in the range of (0.022 mg/kg^{-1}) in wild boar sausage and (0.042 mg/kg^{-1}) for wild boar bacon (figure 1).

Zinc (Zn) showed the highest values of the elements analysed. This metal had the highest values in wild boar bacon (1.83 mg/kg^{-1}) and (1.98 mg/kg^{-1}) in wild boar salami.

In another article, written by Lenti et al., a presence of heavy metals such as lead (Pb) was determined in the boar meat sauce called "ragù". A few samples were gathered for analyzation from different parts of Italy. The technique used for measurements was ICP-MS. The result was an average of 0.10 mg/kg, a quantity permitted in Europe in the case of domesticated animal meats, while the measurements varied from 0.01 mg/kg to 18.3 mg/kg. Concentrations of heavy metals found by us in the meat varied in between 0.004 mg/kg^{-1} - the least amount and 0.011mg/kg^{-1}- the most amount. Another study was conducted by Barone et al. on pork products from Italy. Those products were: roasted meat (15 samples) and raw bacon (16 samples), mortadella (15 samples), salami (20 samples), raw sausages (16 samples) and würstel (18 samples). Thus, they obtained Cd: 0.01-0.03 μg/g−1 w.w, Cu: 1.08–1.21 μg/g^{-1} w.w, Zn: 5.71–7.32 μg/g^{-1} w.w and Pb: 0.22–0.38 μg/g^{-1} w.w. The authors noted that each metal was within the permissible range. They also used the atomic absorption spectrophotometry analysis procedure to measure the 100 samples.

Compared to the results found by us in the case of Cadmium and Copper, the products made from boar meat had a greater concentration than those from pork; respectively in the case of Zinc and Lead our results showed a lesser concentration than those from pork meat. The problem with these heavy metals is their tendency to bioaccumulate. Metals enter a living organism, animal or human, way faster than they are metabolized (Ciobanu et al., 2020).

Accumulation of these substances can over time affect the body (Ciobanu et al., 2020). Lead is known for damaging the nervous system and causing problems to the immune, cardiovascular and reproductive systems, while also being carcinogenic to humans (Lenti et al., 2020). Cadmium can cause hypertension, fragile bones, poor reproductive capacity and tumors. Zinc is known for having a negative impact on the gastrointestinal system and cooper is known for causing inflammation in brain tissue, kidney and liver dysfunction, learning disorders and cancer (Barone et al., 2021).

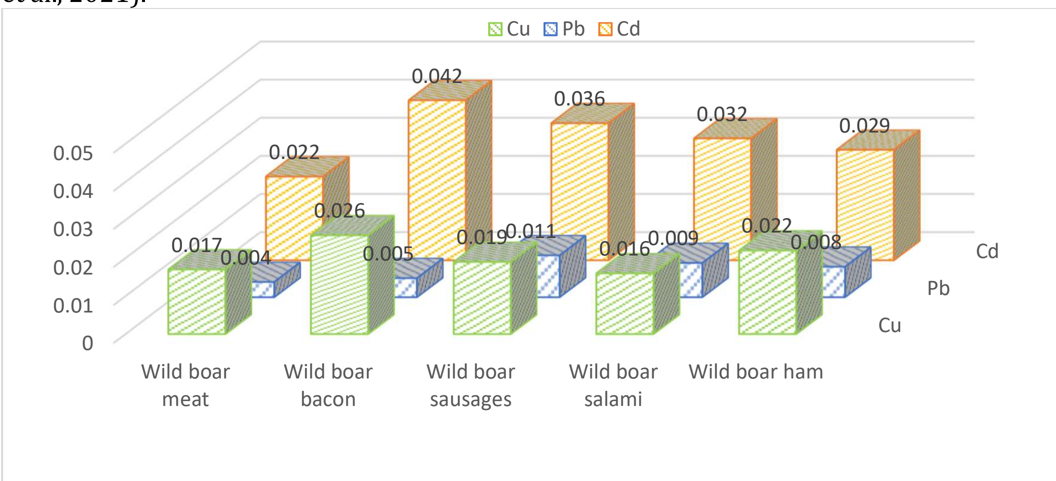

Fig. 1. Average content of Cooper (Cu), Lead (Pb), Cadmium (Cd) (mg/kg^{-1}w.w) in wild boar meat, bacon, sausages, salami and ham.

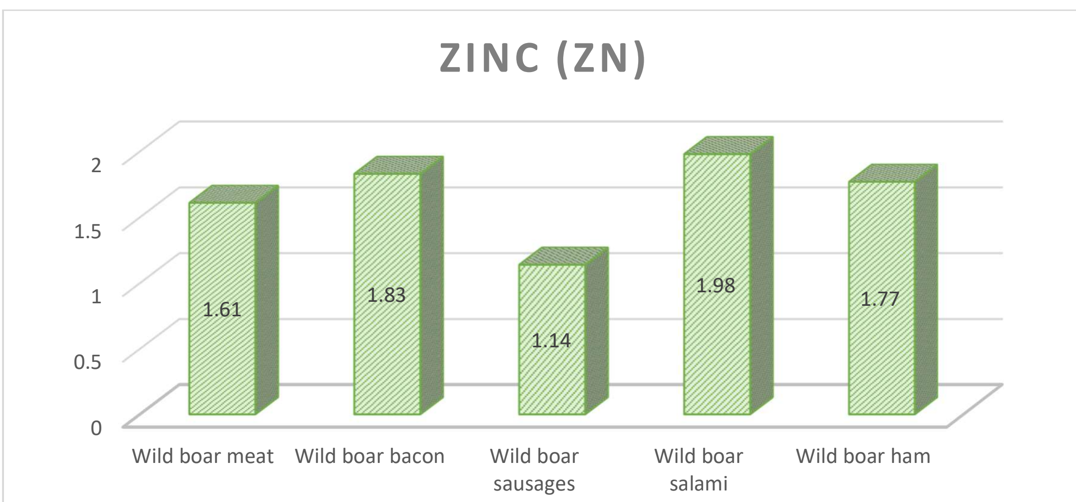

Fig. 2. The average zinc content (Zn) (mg/kg^{-1}w.w) of wild boar meat, bacon, sausages, salami and ham.

CONCLUSION

In conclusion, heavy metals are present in wild boar meat products in different quantities, and exposure to these substances can harm humans. In this case, the analysis of meat before marketing is very important.

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