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ASSESSMENT OF THE CADMIUM AND LEAD AND DETERMINATION OF THE PHYSICO-CHEMICAL COMPOSITION OF GAME MEAT AND PIGMEAT

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Abstract

Meat is one of the most popular and valued foods globally. It is part of the daily diet of the majority of the population, especially in developed countries. At the "diplomatic" level, this product represents the prosperity of a country, so in underdeveloped regions, not everyone has access to this product and the quantities are much lower. Being so loved by consumers, meat can be very dangerous. Improperly treated, stored in poor hygienic conditions or marketed without preliminary analyzes, it can easily transmit various parasites, which leads to mass disease of the population. The meats have different chemical properties depending on the species from which they come from. So they can be healthier or more unhealthy for the human body. By physico-chemical analysis, both the quality of the meats and the degree of their contamination can be determined. One of the most dangerous contaminations is the contamination with heavy metals, for example with lead, cadminu, copper, etc., because their repeated and periodic ingestion leads to serious health problems, several organs being affected.

Key words: meat, heavy metals, physicochemical properties, contamination

INTRODUCTION

Heavy metals and other pathogenic organisms are the most harmful pollutants produced by industry and urbanization, as they may cause major health issues in humans. Heavy metals are prevalent in the environment because of the human activity, and individuals encounter them mostly through food ingestion. (Halagarda et al., 2022). Pesticides, fertilizers, industrial processes, and automotive exhaust fumes are the primary causes of heavy metal pollution, which are all on the rise (Nriagu, 1988).

Heavy metal pollution, particularly lead, cadmium, and mercury, is one of the most serious risks to human health. When heavy metals are not absorbed by the body and accumulate in tissues, they become poisonous (Järup, 2003). Because heavy metals tend to accumulate in living creatures, they are harmful. During the manufacturing of food, certain heavy metals are deposited as residues (Rai et al., 2019).

Lead accumulates in plants and animals in general, and its concentration is amplified throughout the food chain (Amari et al., 2017). Cadmium has a lengthy half-life (between 10 and 40 years) in the human body, particularly in the kidneys (Barregard et al., 2022). High quantities of Cu and Zn in pig and poultry diets can contaminate generated manure in some situations. If this is used as fertilizer on agricultural land, it may pollute the land with these metals, posing a contamination concern for other creatures who eat the vegetation grown in that field (Fei et al., 2022).

Food contamination with different environmental contaminants, particularly heavy metals, has grown as food production and processing technologies have progressed. Numerous studies have demonstrated the presence of heavy metals in beef products, notably lead and cadmium (Harlia et al., 2015). If residual levels exceed the prescribed standards, they will have negative health consequences due to the cumulative effect in the human body as a result of repeated and persistent ingestion. It is therefore the responsibility of all farmers and meat processors to reduce the chances of contamination.

Pork products, whether fresh or processed, are the most widely eaten meat on the planet. We felt it was vital to examine the levels of heavy metals in pig products, in order to offer information on consumer exposure to a potential risk of toxicity, given the increased interest of consumers in food safety and pork products. Besides the increased interest in pork products, the aim of this study is also to evaluate the levels of heavy metals in game meat being a highly desired delicacy and discovering the recent environmental effects of eastern Europe.

MATERIAL AND METHOD

Determination of Pb and Cd concentration

The atomic absorption spectrophotometry is based on the determination of the concentration of a chemical element in the sample to be analyzed, by measuring the absorption of an electromagnetic radiation with a specific wavelength, when it passes through the environment in which the free atoms of that element are evenly distributed. The most advanced and widespread technique for determining low concentrations of heavy metals in samples is the atomic absorption technique with graphite furnace.

By mineralizing the sample, the constituent elements are removed from the organic combinations and brought into the state of mineral compounds, which are then passed by dissolution in acid solution.

Reagents needed to perform the analyses:

- High purity water (ultrapure with 2 ppb OCD). It is kept only in plastic containers, tightly closed.
- Standard solution of Pb c = 1000 mg/l (in HNO3 0.5 mol/l)
- Standard solution cd c = 1000 mg/l (in HNO3 0.5 mol/l)
- Hydrochloric acid minimum 37 % fraction by mass, from which is prepared 6 mol/l hydrochloric acid solution as follows: 500 ml of hydrochloric acid is made up to the mark with ultrapure water in bacon rated 1000 ml
- Nitric acid, minimum 65% fraction of the mass from which is made up nitric acid solution 0,1mol/l as follows: dilute 7 ml of concentrated nitric acid with water to 1000 ml.

Standard solutions for the elements: Pb, Cd, are prepared from concentrated solutions (1000 mg / l). A volume of 1.0 ml is measured from the Pb solution, which is brought with 0,2 % nitric acid solution per 100 ml in the volumetric flask and homogenized well. This is the stock solution that contains 10 microgram/ml (10 ppm). The solution can be kept for three months. A volume of 0.1 ml is measured from the Cd solution, which is brought with 0,2 % nitric acid solution per 100 ml in the volumetric flask and homogenized well. This is the stock solution that contains 1.0 microgram/ml (1 ppm).

Table 1

Concentrations of standard solutions

Standard solution	Stock solution (ppm)	Solution for use no.1 (ppb)
Lead	10	50
	10	10
Cadmium	1	10

About 45 minutes before the determination, open the apparatus, choose the technique of working at the graphite furnace, operate the lamp corresponding to the first element to be determined, open the argon cylinder, check the alignment of the graphite furnace and the pipette of the autosampler - all these according to the working instructions accompanying the apparatus. Place in the autosampler tray the calibration reagent ,the solution for use no.1, the blank reagent and the samples.

Plot the calibration curve and read the concentration of the element in the curve. The content is calculated, w, as a fraction of the mass of the element to be determined, in milligrams per kilogram of sample, using the following formula:

- w- concentration in the sample, mg/kg
- the concentration of the element determined from the sample solution, μg/l

- V - final volume of the sample solution, ml
- F- dilution factor
- m- mass of the sample, g

Depending on the mass of the sample, the final volume of the mineralization or of the dilutions made, the software of the device processes these data and displays the result directly.

Determination of hydrolyzed light nitrogen

Released easily hydrolysis nitrogen (ammonia) using a weak base is entrained by distillation with water vapor and captured in an acidic solution, in which it is dosed by titration with NaOH solution.

Weigh about 10 g of the sample to be analysed and pass into the distillation flask with about 250 cc of distilled water. In the collector bowl place 5-15 cc sulfuric acid, 2 or 3 drops of methyl red solution and 5-10 cc of water. Immerse the refrigerant extension with 4-5 mm in the solution in the collector vessel. In the distillation flask, add 1-2 g of magnesium oxide and 5-10 cc of paraffin oil to avoid foaming. Then wash the walls of the flask with water, shake and adapt to the distillation sistem. Bring to a boil in 10 minutes and distill for 25 minutes. Near the end of the distillation, lower the collecting vessel so that the refrigerant extension remains above the level of the liquid. After completing the distillation, wash the upper end of the refrigerent with a few cc of water. Titrate the liquid in the collecting vessel with NaOH.

For meat, the content of easily hydrolysis nitrogen, expressed as ammonia in mg/100 g, is calculated using the formula:

$$\text{Easily hydrolysis nitrogen, mg NH3/100 g} = \frac{0.0017\ (V1\text{-}V2)x\ 103}{m} \times 100,$$

- 0.0017= the amount of ammonia in grams, corresponding to a sulphuric acid of 0.1 n;
- V1 = volume of sulphuric acid 0.1 n introduced into the collector vessel in cm3
- V2 = volume of NaOH, 0,1 n solution used for titration in cm3
- m = mass of the sample taken for determination, in grams

Determination of protein content

The principle consists in mineralization of the organic substance with sulfuric acid in the presence of a catalyst, alkalization of reaction compounds, distillation and titration of the released ammonia.

The equipment we used is : precise electronic analytical balance with 4 decimal places Type 320 XT model 220A, Kjeldahl line, model Büchi, mechanical meat grinder, laboratory mill

Reagents needed to perform the analyses: catalyst copper sulphate, sulphuric acid density 1,84 g/ml, paraffin, sucrose, sodium hydroxide 33 % solution (m/m), recovery fluid boric acid 40 g/l solution, titration solutions sulfuric acid 0,1 n and hydrochloric acid 0.1n, boric acid solution 4, boiling regulator.

Prepare the sample by passing it at least twice through the grinder and mix well. It is kept in a hermetically sealed container. It is analyzed within 24 hours of the training. Weigh a quantity of the sample for analysis, so that the sample to be analyzed contains between 0.005 g and 0.2 g nitrogen. The quantity of the sample to be analyzed must be between 0.5 g and 2 g. Introduce the sample in the tube of the mineralization block and then the catalyst (0.5g copper sulfate + 15g anhydrous potassium sulphate) and 25 ml sulfuric acid.

Mineralization is carried out at high temperature. The sample is mineralized when the mixture in the tube has a clear blue-green color. Remove the tube from the stand and mount it in the distillation unit. In the catchment vessel into which the pH meter electrode is inserted, the volume of 60 ml of boric acid is absorbed. Distillation takes 3 minutes.

Titration is performed with the automatic indication of the final point with the help of the pH-meter.

The total nitrogen content, expressed as a percentage by mass, is equal to:

$$\frac{0.0014(V_1 - V_0) * 100}{m}$$

- V0 - soil volume of hydrochloric acid 0.1N used for the blank, ml
- V1 - soil volume of hydrochloric acid 0.1N used for the determination, ml
- m - mass of the sample to be analyzed, g

Determination of pH

The potential difference is measured between a glass electrode and a reference electrode, which is inserted into a sample or extract of a sample of meat or meat product.

Make a hole in the sample and carefully insert the electrode. Set the temperature correction system within the pH-meter at the sample temperature. After reaching the constant value, read the pH directly at the pH-meter with an accuracy of 0.01 pH units.

Determination of fat content

The principle of the method consists in extraction with n-hexane or petroleum ether, of the dry residue obtained according to the method of determining the moisture content specified in ISO 1442 and removal of the solvent by evaporation, then drying and weighing the extract.

Calculation is made acoording to the following formula:

Gr % =((m2- m1) / m)x 100 Where :

- m2- the mass of the aluminum cup with fat after drying (g)
- m1- the mass of the empty aluminum beaker (g)
- m- mass of the sample taken into work (g)

RESULTS AND DISCUSSION

Figure 1 show the content for Pb (mg/kg) in pig and wild boar muscle tissue: for pig muscle tissue 0.052±0.001 mg/kg, and for wild boar muscle tissue 0.075±0.016 mg/kg.

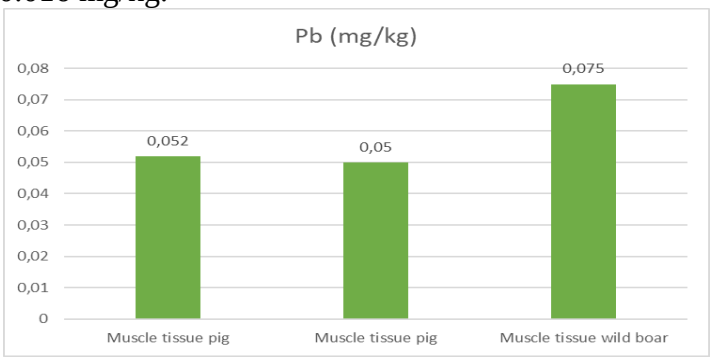

Fig 1. The lead content of pig and wild boar muscle tissue

In figure 2 are presented values obtained for cadmium: for pork muscle tissue 0.021±0.005 mg/kg, 0.02±0.03 and for wild boar muscle tissue 0.023±0.005 mg/kg.

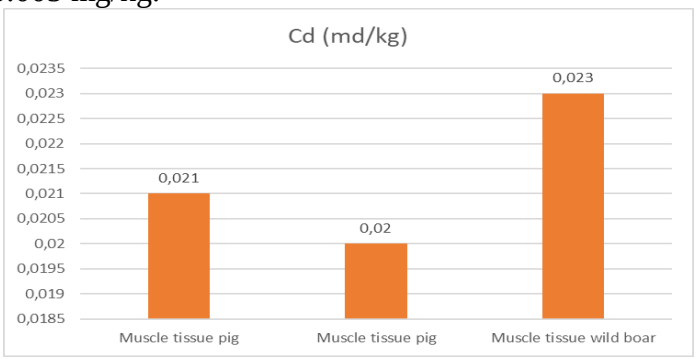

Fig. 2. Cadmium content in pig and wild boar muscle tissue

It was found that more than half of the metals come from plant foods. There are many factors that influence the toxicity of heavy metals in the soil-crop system. The aim is to apply agronomic practices in order to minimize the availability of heavy metals in the soil (Ejazul I. et al. 2007).

Table 2

Values obtained for pork and wild boar from the samples analyzed

	Protein%	Fat%	Easily hydrolyzable nitrogen	PH
Lean pork meat	19.2%	6.5%	28 mg NH_3 / 100g	5.9%
Wild boar meat	20.1%	6.0%	31 mg NH_3 / 100g	6.0%

In the case of the analysis for protein in lean pork meat, a percentage of 19.2% was obtained, and in wild boar 20.1% compared to the results obtained by (Șelaru N. 1995) which were 20.1% for pork and 19.4% for wild boar. In the case of the analysis of the two types of meat, the following average values (%) were obtained for the analyzed samples regarding fat: in the case of lean pork they were 6.5% compared to the results obtained by (Aurelia I. 2009) which were of 5.0%, and the wild boar meat showed a value of 6.0%, so that these values fall within the maximum allowed limit.

The following average values were obtained for the samples analyzed for easily hydrolyzable nitrogen: in the case of pork it was 28 mg (NH_3 / 100g), and in the case of wild boar 31 mg (NH_3 / 100g), these being corresponding to the maximum allowed limits.

The results obtained for the determination of the pH in lean pork were 5.9% and in the case of wild boar meat 6.0%.

CONCLUSIONS

Heavy metals are chemical elements whose concentration needs to be monitored closely because organisms can assimilate these metals and the effects on organisms can be fatal. The level of heavy metals and the physico-chemical composition in the two types of meat is greatly influenced by the external environment. In the case of pork and wild boar the data obtained correspond to the maximum allowed values. These parameters of the meat give us important clues about the quality and safety of pork and wild boar.

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