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To cite this article: V Tomovic *et al* 2021 *IOP Conf. Ser.: Earth Environ. Sci.* **854** 012099

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# Mercury in female cattle livers and kidneys from Vojvodina, northern Serbia

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**Abstract.** Concentrations of mercury (Hg) were analysed in livers (n = 26) and kidneys (n = 26) of female cattle (412–2502 days old) from farms for milk production in the area of Vojvodina. Concentration of Hg was analysed by ICP-OES, after digestion by microwave. The Hg concentrations in the livers and kidneys ranged from below detection limits (LOD < 0.006 mg/kg) to 0.206 mg/kg wet weight and from below detection limits (LOD < 0.006 mg/kg) to 0.018 mg/kg wet weight, respectively.

## 1. Introduction

All types of cattle, whether their primary purpose is meat, milk, draft power or some combination of these, will be used ultimately in beef production [1]. In everyday diet, red meats are the best source of high biological value nutrients (vitamins: vitamin B<sub>12</sub>, niacin and vitamin B<sub>6</sub>, minerals: iron, zinc and phosphorus, proteins). Beside positive effects on diet and health, red meat could potentially be the source of some chemical substances with toxic effects [2-23].

In 2020, in the Republic of Serbia total cattle number was 886,127, and 259,527 of them were raised in the Autonomous Province of Vojvodina [24].

Variety meat, or edible offal, are also a kind of meat even though are not skeletal muscles. They are used as food, and mostly have higher contents of some micro-nutrients, especially vitamins and minerals, comparing to meat tissue [13,25-28]. According to Serbian legislation [29], the edible offal (organs and glands) that are separated in dressing butchered cattle include liver, kidney, spleen, heart, tongue, lungs, brain, thymus and testis. Liver is the most often used organ and is incorporate in recipes for number of different types of processed products of meat. These organs from older cattle animals are much more suited for processed meats, especially for liver paté and sausages, since they possess intensive aroma and are tough. On contrary, kidneys are not usually used in processed products of meat but are generally used as braised, grilled or sautéed either whole or sliced [30].

Mercury (Hg) is recognised as toxic pollutant at global level, which bioaccumulate and biomagnify within the food chain [31]. Hg toxic characteristics have a serious negative impact to both environment and living organisms [32]. This metal is present in soil, water and air, due to both anthropogenic and natural emission sources [33]. The living organisms can adopt mercury from contaminated soil, water and air. In this sources, mercury is transformed by microorganisms to more bioavailable organic forms [34], and is incorporated into next levels of the food chain [35-39]. For vertebrates, the diet is considered to be one of the main sources of exposure to contaminants from environmental [40]. Human population, being at the highest food chain level is exposed to Hg intake from different kinds of food, especially by consumption of fish [41-43], seafood and freshwater crustaceans [44-46], and food of animal origin [47].



The Regulation of European Union [48] only defined maximum levels for total Hg concentration for seafood and fish from 0.5 to 1.0 mg/kg wet weight. FAO/WHO Expert Committee on Food Additives (JECFA) established PTWI (provisional tolerable weekly intake) for methylmercury of 1.6 µg/kg body weight and of 4 µg/kg body weight for inorganic mercury. The PTWI for methylmercury of 1.6 µg/kg body weight/week corresponds to 0.112 mg/week for a person weighing 70 kg [49,50].

Studies aiming to determine concentration of Hg in animal tissues were conducted in number of countries and regions. The available literature indicate a large variability in the concentrations of Hg in muscle tissue and offal of cattle [51-61].

The concentrations of toxic (heavy) elements in food must be permanently monitor and control in order to protect or/and reduce their negative effects on human health. Considering the fact that there is a lack of information about Hg content in cattle tissues from Vojvodina, the goals of this paper were (i) to measure Hg levels in livers and kidneys from adult dairy cattle in the Autonomous Province of Vojvodina and (ii) to determine possible trends in bioaccumulation of Hg in cattle tissues.

## 2. Materials and methods

Samples (liver and kidney) were collected from 26 cattle slaughtered at the slaughterhouse in Novi Sad (Vojvodina, northern Serbia), during 26 consecutive weeks (i.e. samples from one animal per week were collected). All animals were slaughtered for human consumption. Slaughtered heifers and cows (female cattle) came from 26 different farms for milk production (i.e. one animal per farm was sampled) in Vojvodina (northern Serbia), so it can be stated that samples of liver and kidney were collected from the whole region. Information about animals (date of birth, sex and type of the animal) were received from farms with copy of the passport. The investigated cattle aged from 412 to 2502 days.

Samples (liver and kidney) were collected from the same cattle and minced in a stainless steel cutter. After homogenization, approximately 250 g of samples were taken for analysis. Samples were vacuum packed in polyethylene bags and stored at constant temperature (-80°C) until determination of Hg. Hg content was determined using ICP-OES (inductively coupled plasma-optical emission spectrometry, iCAP 6000 Series, Thermo Scientific, Cambridge, UK) method, after digestion by microwave (MWS-3+, Berghof, Germany). Hg contents are showed as mg/kg wet weight. Standard reference material (ERM-CE278, mussel tissue IRMM, Institute for Reference Materials and Measurements, Geel, Belgium) was used for quality control of the analytical measurement. The results obtained for the analytical quality control programme are showed in Table 1.

**Table 1.** The results obtained for analytical quality control programme (n = 5)

| Analyte    | Matrix  | Certified concentration | Found concentration | LOD   | LOQ   |
|------------|---|-------------------------|---------------------|-------|-------|
| Hg (mg/kg) | ERM – CE278, Mussel tissue, IRMM, Geel, Belgium | 0.196                   | 0.191               | 0.006 | 0.015 |

## 3. Results and discussion

Concentrations of Hg in the analysed samples are showed in Table 2.

**Table 2.** Individual Hg concentration (mg/kg wet weight) in the edible offal of female cattle raised in Vojvodina

| No | Liver | Kidney |
|----|-------|--------|
| 1  | 0.206 | 0.010  |
| 2  | 0.121 | 0.015  |

|    |         |         |
|----|---------|---------|
| 3  | 0.057   | 0.018   |
| 4  | 0.069   | < 0.006 |
| 5  | 0.063   | < 0.006 |
| 6  | < 0.006 | 0.011   |
| 7  | 0.043   | < 0.006 |
| 8  | 0.021   | 0.014   |
| 9  | 0.019   | 0.013   |
| 10 | 0.015   | < 0.006 |
| 11 | 0.009   | 0.012   |
| 12 | 0.009   | 0.012   |
| 13 | 0.013   | 0.015   |
| 14 | 0.010   | 0.006   |
| 15 | 0.009   | 0.008   |
| 16 | < 0.006 | < 0.006 |
| 17 | 0.012   | 0.008   |
| 18 | < 0.006 | 0.006   |
| 19 | < 0.006 | 0.011   |
| 20 | 0.008   | < 0.006 |
| 21 | < 0.006 | 0.011   |
| 22 | < 0.006 | < 0.006 |
| 23 | < 0.006 | < 0.006 |
| 24 | < 0.006 | < 0.006 |
| 25 | < 0.006 | < 0.006 |
| 26 | < 0.006 | < 0.006 |

The Hg concentrations of the female cattle liver and kidney were in the range from below detection limits (LOD < 0.006 mg/kg) to 0.206 mg/kg wet weight and from below detection limits (LOD < 0.006 mg/kg) to 0.018 mg/kg wet weight, respectively.

Reported Hg concentrations in foods, that is, red meat and edible offal of cattle, vary widely (Table 3).

**Table 3.** Mean concentrations (mg/kg wet weight) of Hg in red meat and edible offal of cattle from different countries

| Meat  | Liver | Kidney | Country | Source |
|-------|-------|--------|---------|--------|
| 0.005 | 0.006 | 0.010  | Sweden  | [51]   |

|                            |                            |                            |                |      |
|----------------------------|----------------------------|----------------------------|----------------|------|
| < LOD-0.0191<br>(interval) | < LOD-0.0938<br>(interval) | < LOD-0.0733<br>(interval) | Spain          | [52] |
| 0.011                      | 0.012                      | 0.015                      | Finland        | [53] |
| 0.0012                     | 0.0042                     | 0.011                      | Poland         | [54] |
|                            | 0.02<br>(median)           | 0.02<br>(median)           | USA            | [55] |
|                            |                            | 0.006<br>(geometric mean)  | Croatia        | [56] |
|                            |                            | 0.008                      | Ireland        | [57] |
|                            | 0.0003<br>(median)         | 0.004<br>(median)          | Zambia         | [58] |
|                            | < LOD-0.100                | < LOD-0.481                | Serbia         | [59] |
| 0.00391                    | 0.00581                    | 0.01014                    | Egypt          | [60] |
| 0.0210                     | 0.0243                     | 0.0510                     | Czech Republic | [61] |
| 0.0011                     | 0.0033                     | 0.0183                     |                |      |

#### 4. Conclusion

The literature indicates a large variability of Hg concentration in red meat and edible offal (liver and kidney). The available data showed that considerable regional differences exist for the Hg concentration of animal edible tissues. Thus, content of Hg in edible offal (liver and kidney) can be used as relevant indicator of environmental contamination by Hg. Generally, monitoring and control of Hg in living organisms, i.e. red meat and edible offal, is necessary.

#### Acknowledgements

This research was funded by the Ministry of Education, Science and Technological Development, Republic of Serbia, under Grant 451-03-9/2021-14/200134. Also, this research has been done in liaison with the activities defined by the grant for the establishment and implementation of the research-innovation-scientific program “Centre of Excellence (CoE) for digitalization of microbial food safety risk assessment and quality parameters for accurate food authenticity certification (FoodHub)”, financed by the Ministry of Science of Montenegro, under the Grant No. 01-3660/2.

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