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## Total phosphorus content in various types of cooked sausages from the Serbian market

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### Abstract

In the period January 2014 to March 2015, phosphorous levels were measured in 701 samples of different types of cooked sausages from the Serbian market. The highest level of phosphorus (9.52 g/kg, expressed as P<sub>2</sub>O<sub>5</sub>) was found in fine comminuted sausage, and the lowest (0.94 g/kg) in meat pâté. The most common (33.38%) range of phosphorous levels was 4.01-5.00 g/kg P<sub>2</sub>O<sub>5</sub>. National Regulation allows total phosphorus content (as P<sub>2</sub>O<sub>5</sub>) up to 8.00 g/kg. Only three sausages (0.43%) did not meet this requirement, but the rest of the analyzed sausages (99.57%) were safe for consumption, with respect to content of phosphorus.

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### 1. Introduction

Phosphorus is an essential element for the functioning of all living organisms. The main functions of phosphorus in human beings are: it contributes to structure of bones and teeth, it is fundamental to the transfer of energy within

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cells and thus to all body functions, it participates in the transport of fatty acids, it is a vital element in the structure of DNA – without it, DNA cannot form and it is essential element in many proteins<sup>1</sup>. The human body contains about 560 to 850 g of phosphorus, representing about 0.8% to 1.2% of body weight. Of the total phosphorus in the body, about 85% is in the skeleton, 1% is in the blood and body fluids and the remaining 14% is associated with soft tissue such as muscle. After calcium, phosphorus is the second most abundant mineral in the human body<sup>2</sup>.

Low intake of phosphorus can lead to symptoms include anorexia, anaemia, muscle weakness, bone pain, rickets, and ataxia<sup>3</sup>. Inadequate intake of calcium and phosphorus has been associated with pathogenesis of bone disease in newborn infants<sup>4</sup>.

The inorganic phosphate fraction in the extracellular fluid is under endocrine control of the parathyroid-vitamin D axis. Excess phosphorus intake can result in hyperphosphatemia and a consequent increase in serum parathyroid hormone (PTH) level. Secondary hyperparathyroidism leads to increased bone resorption, which can adversely affect bone mineral density and skeletal integrity, and result in ectopic calcification. Such phosphorus induced effects have been observed in animal studies, but not in humans, except in patients with end-stage renal disease. As long as the kidney function is adequate the excess phosphate is excreted. In some supplementation studies using high phosphorus dosages, osmotic diarrhea and mild gastrointestinal symptoms have been reported<sup>5</sup>.

Intake of too much phosphate can be toxic. It can cause diarrhea and calcification (hardening) of organs and soft tissue, and can interfere with the body's ability to use iron, calcium, magnesium and zinc<sup>6</sup>. Zimonjić et al.<sup>7</sup> stated that phosphates additives may exhibit a cytotoxic activity, if they are too heavily contaminated with toxic heavy metals.

According to Institute of Medicine recommendations<sup>8</sup>, the recommended dietary intakes of phosphorus are as follows: 0 to 6 months - 100 milligrams per day (mg/day); 7 to 12 months - 275 mg/day; 1 to 3 years - 460 mg/day; 4 to 8 years - 500 mg/day; 9 to 18 years - 1250 mg; Adults - 700 mg/day; Pregnant or lactating women: Younger than 18 - 1250 mg/day; Older than 18 - 700 mg/day.

Phosphates are widely used as additives in the meat industry, in the production process of different types of meat products. Added phosphate has an important role in increasing water holding capacity (WHC) in order to produce stabilized meat emulsions, improve texture, prevent change of colour and oxidation of unsaturated fatty acids, pH value adjustment, extend shelf-life and improve taste of product etc<sup>9,10,11,12</sup>. National Regulations allows content of total phosphorus up to 8 g/kg<sup>13</sup>, and also up to 5 g/kg<sup>14</sup> of added phosphorus, both expressed as P<sub>2</sub>O<sub>5</sub>.

The aim of this study was to determine phosphorus content in different types of cooked sausages, from both domestic and foreign producers.

## 2. Materials and methods

In the period January 2014 to March 2015, 701 samples of different types of cooked sausages were examined (Table 1). Samples were collected from the Serbian market, and were produced by domestic or foreign producers. Total phosphorus (natural and added) content was determined according to standard ISO procedure<sup>15</sup> and expressed as P<sub>2</sub>O<sub>5</sub> in g/kg. The principle of the method is based on drying the test portion and incineration of the residue. After cooling, hydrolysis of the ash was performed with nitric acid. Filtration and dilution were followed by the formation of a yellow compound with a mixture of ammonium monovanadate and ammonium heptamolybdate. Photometric measurement at a wavelength of 430 nm was performed on Halo DB-20/DB-20S, Dynamica, UK. Statistical analysis of the results and graphical presentation of their distribution was performed using Microsoft Office Excel 2007.

## 3. Results and discussion

The results of determination of total phosphorus content (expressed as P<sub>2</sub>O<sub>5</sub>, g/kg) in the examined samples of sausage meat products were showed in Table 1. Also, distribution of the results is graphically presented in Fig. 1. The highest level of phosphorus detected (9.52 g/kg) was measured in a fine comminuted cooked sausage made by a domestic producer. On the other hand, the lowest level of phosphorus detected (0.94 g/kg) was found in meat pâté in casing.

Table 1. Total phosphorus content expressed as  $P_2O_5$  (g/kg) in cooked sausages for the period January 2014 – March 2015.

Type of product	Producers	$n^a$	Min	Max	$X_s^b \pm S_d^c$	CV <sup>d</sup> (%)	$n^e$	%
Fine comminuted cooked sausages	Domestic	314	1.99	9.52	$4.89 \pm 1.10$	22.49	3	0.96
	Foreign	51	1.65	7.76	$4.93 \pm 1.07$	21.70	0	/
Coarse comminuted cooked sausages	Domestic	151	2.60	7.76	$4.95 \pm 1.06$	21.41	0	/
	Foreign	20	2.51	6.73	$4.64 \pm 1.24$	26.72	0	/
Meat Pâté (tin)	Domestic	68	1.79	4.51	$2.39 \pm 0.43$	17.99	0	/
	Foreign	54	1.76	4.90	$2.75 \pm 0.66$	24.00	0	/
Meat Pâté (casing)	Domestic	43	0.94	4.73	$2.58 \pm 0.87$	33.72	0	/
	Foreign	/	/	/	/	/	/	/
Total	All	701	0.94	9.52	$4.35 \pm 1.41$	32.41	3	0.43

<sup>a</sup> number of samples

<sup>b</sup> average value

<sup>c</sup> standard deviation

<sup>d</sup> coefficient of variation

<sup>e</sup> number of samples which do not meet the requirements of National Regulations (Republic of Serbia)<sup>13</sup>

National Regulation<sup>13</sup> allows total phosphorus content up to 8.00 g/kg, expressed as  $P_2O_5$ , and only three sausages (0.43% of total number of analyzed products) did not meet this requirement, with range of values between 9.01-10.00 g/kg  $P_2O_5$  (Table 1, Fig. 1). The most common range of phosphorous levels was 4.01-5.00 g/kg  $P_2O_5$ , which was the level detected in 234 (33.38%) of the total number of analyzed sausages (Fig. 1).

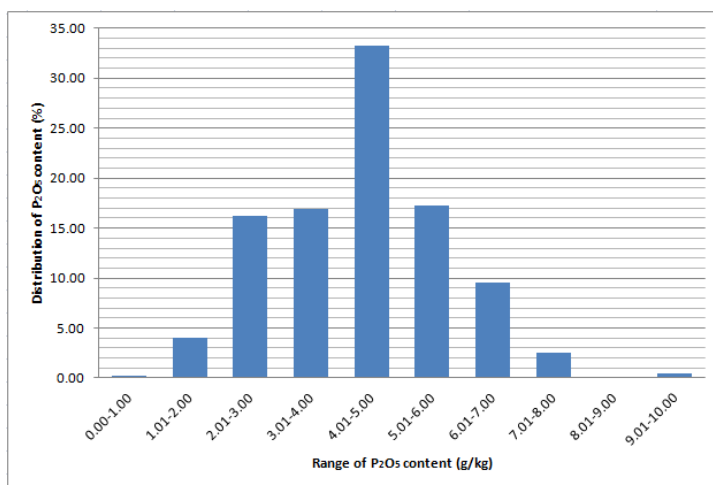


Fig. 1. Distribution of  $P_2O_5$  levels in various types of cooked sausages.

#### 4. Conclusion

The vast majority of analyzed sausages (99.57%) in the period January 2014 to March 2015 met the requirement of the Serbian National Regulation<sup>13</sup> for phosphorous level (maximum 8.00 g/kg of total phosphorus, expressed as  $P_2O_5$ ). Therefore, with respect to phosphorus content in the various types of cooked sausages examined from the Serbian market, the greatest number, from both domestic and foreign producers, were safe for consumption.

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