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

Vladimir Koricanac^{a,*}, Danijela Vranic^a, Slobodan Lilic^a, Dragan Milicevic^a,
Sladjana Sobajic^b, Milica Zrnic^b

^a*Institute of Meat Hygiene and Technology, Kacanskog 13, 11000 Belgrade, Serbia*

^b*Faculty of Pharmacy, University of Belgrade, Department of Bromatology, Vojvode Stepe 450, Belgrade 11221, Serbia*

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 P₂O₅) 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 P₂O₅. National Regulation allows total phosphorus content (as P₂O₅) 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

* Corresponding author. Tel.: +381-11-2650-655; fax: +381-11-2651-825.
E-mail address: vladimir@inmesbgd.com

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 proteins¹. 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 body².

Low intake of phosphorus can lead to symptoms include anorexia, anaemia, muscle weakness, bone pain, rickets, and ataxia³. Inadequate intake of calcium and phosphorus has been associated with pathogenesis of bone disease in newborn infants⁴.

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 reported⁵.

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 zinc⁶. Zimonjić et al.⁷ stated that phosphates additives may exhibit a cytotoxic activity, if they are too heavily contaminated with toxic heavy metals.

According to Institute of Medicine recommendations⁸, 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^{9,10,11,12}. National Regulations allows content of total phosphorus up to 8 g/kg¹³, and also up to 5 g/kg¹⁴ of added phosphorus, both expressed as P₂O₅.

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 procedure¹⁵ and expressed as P₂O₅ 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 P₂O₅, 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 P₂O₅ (g/kg) in cooked sausages for the period January 2014 – March 2015.

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

^a number of samples

^b average value

^c standard deviation

^d coefficient of variation

^e number of samples which do not meet the requirements of National Regulations (Republic of Serbia)¹³

National Regulation¹³ allows total phosphorus content up to 8.00 g/kg, expressed as P₂O₅, 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 P₂O₅ (Table 1, Fig. 1). The most common range of phosphorous levels was 4.01-5.00 g/kg P₂O₅, which was the level detected in 234 (33.38%) of the total number of analyzed sausages (Fig. 1).

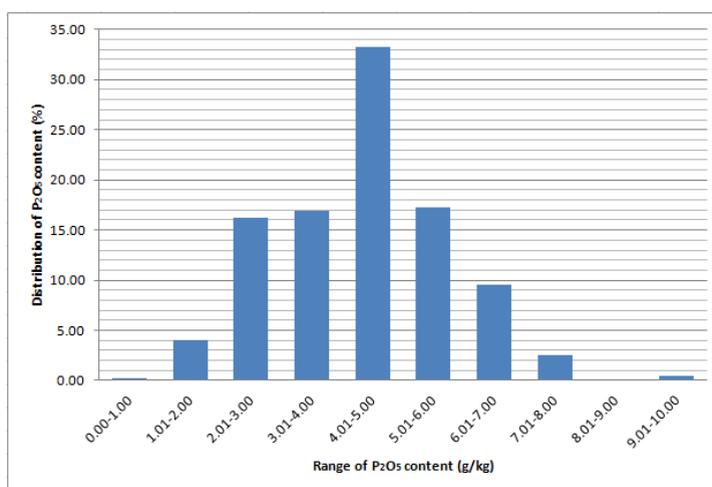


Fig. 1. Distribution of P₂O₅ levels in various types of cooked sausages.

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 Regulation¹³ for phosphorous level (maximum 8.00 g/kg of total phosphorus, expressed as P₂O₅). 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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References

1. http://ec.europa.eu/enterprise/policies/raw-materials/files/pc-contributions/org-020-cefic-fertilizers-europe-papa-ifp-ceep_en.pdf.
2. Gropper SS, Smith JL. *Advanced Nutrition and Human Metabolism*, 6th ed. Belmont: Yolanda Cossio; 2013.
3. Lotz M, Zisman E, Bartter FC. Evidence for a phosphorus-depletion syndrome in man. *N Eng J Med* 1968;**278**:409-15.
4. Bishop N. Bone disease in preterm infants. *Arch Dis Child* 1989;**64**:1403-9.
5. Opinion of the Scientific Panel on Dietetic Products, Nutrition and Allergies on a request from the Commission related to the Tolerable Upper Intake Level of Phosphorus, Request N° EFSA-Q-2003-018. *The EFSA Journal* 2005;**233**:1-19.
6. Donald Webb, *Medical Meanderings*, CMT; 2006.
7. Zimonjic DB, Savković N, Andjelkovic M. *Genotoksicni agensi: efekti, principi i metodologija detekcije*. Beograd: Naučna knjiga; 1990.
8. Institute of Medicine. Food and Nutrition Board. Dietary Reference Intakes for Calcium, Phosphorous, Magnesium, Vitamin D, and Fluoride. Washington (DC): National Academies Press (US); 1997.
9. Knipe L. Use of Phosphates in Meat Products. *Meat Industry Research Conference*, October 2. 2004.
10. Knipe L. Phosphates as meat emulsion stabilizers, In: Benjamin C. editor. *Encyclopedia of Food Sciences and Nutrition*, Oxford: Academic Press, 2003. p.2077-2080.
11. Saicic S, Vranic D, Trbovic D, Pavlov N, Sadržaj ukupnog fosfora u proizvodima od mesa. *Tehn mesa* 2008;**3-4**:147-152.
12. Vukovic I. *Osnove tehnologije mesa*, 3. izdanje, Beograd: Veterinarska komora Srbije; 2006.
13. Pravilnik o kvalitetu usitnjenog mesa, poluproizvoda od mesa i proizvoda od mesa, Sl. glasnik RS, br. 31/2012 i 43/2013 – dr. pravilnik.
14. Pravilnik o prehrambenim aditivima, Sl. glasnik RS, br. 63/2013.
15. ISO 13730:1996 Meat and meat products - Determination of total phosphorus content - Spectrometric method, Geneva: ISO, 1996.