

STUDY ON THE NUTRITIONAL QUALITY OF FRESH SAUSAGES FROM ROMANIA

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Abstract

The purpose of this study was the comparative analysis of nutritional quality of fresh refrigerated sausages, marketed under their own brand in the main supermarkets in Romania (A, B, C, D, E, F), based on chemical composition and energy value. They were analyzed 36 samples (six product samples for each store) purchased in July 2017. The content of proteins, lipids, collagen and water was determined using the automatic analyzer Food Check (infrared spectrophotometer); the mineral substances were determined by calcinations and nitrogen free extract (NFEs) and energy value were determined by calculation, using conventional formulas. The data obtained were statistically processed, including by analysis of variance (Anova One Way, Multiple Comparison), being observed significant and very significant differences for the most parameters analyzed. The lipid content varied most with differences of 138.7 g/kg of product (from 95.7 g/kg in stores F to 234.4 g/kg in stores E); protein content had lower variations, with differences of 61.5 g/kg of product (from 132.8 g/kg for store E to 194.3 g/kg for store F). The energy value was higher, over 270.23 kcal/100g meat, for products from sources A, B, E, and for sources C, D, F, was below 195.7 kcal/100g.

Key words: sausages, proteins, lipids, collagen, water

INTRODUCTION

The consumption of fresh ground meat preparations is widespread due to their pleasant taste and ease of cooking [2].

The purpose of this study was the comparative analysis of nutritional quality of fresh refrigerated sausages (the majority of pork), marketed under their own brand in the main supermarkets in Romania, based on chemical composition and energy value.

Pork is one of the most important animal-based protein sources worldwide. Sausage is one of the most eaten and produced processed meat products [7].

The relatively high cholesterol level and low polyunsaturated/saturated fatty acid ratio (PUFA/SFA) are the risk factors for some disorders such as coronary diseases [11].

However, relevant concerns exist about the fat and/or cholesterol levels in meats and meat products, and several recent studies have sought animal fat substitutes that meet functional and sensory characteristics and improve the lipid profile of the final product [9, 12, 8]. A possible strategy to increase the nutritional value and to

achieve additional health benefits of meat products is to enhance the fatty acid profile by the addition of healthier oils which are low in SFA and rich in monounsaturated fatty acids (MUFA) and PUFA [5].

MATERIAL AND METHOD

The material studied was represented by 36 samples of fresh sausages (the majority of pork), marketed under its own brand in the main supermarkets from Iasi, Romania (A, B, C, D, E), six samples of the product from each source, purchased in July 2017. The content of water, proteins, lipids, and collagen was determined with the automatic analyzer Food Check (infrared spectrophotometer); the mineral substances were determined by calcination (in a furnace at 550 °C—AOAC, 1995), and nitrogen free extract (NFEs) and energy value were determined by calculation, using conventional formulas. The conversion factors were: for proteins 4.27, for lipids 9.02 and for nitrogen free extract 3.87 (after FAO, 2003) [1, 6]. The results obtained were statistically processed, including through analysis of variance (Anova One Way, Multiple Comparison, GraphPad Prism 7).

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RESULTS AND DISCUSSIONS

The chemical composition and the energy value of each product studied are presented in Table 1 - Table 6.

The products from source B and source F had very different characteristics: a fat content of 22.65% and 9.57% respectively, proteins 19.43% versus 17.15%, water 56.43% vs. 68.65%, salt 3.43% vs. 0.48% and a calculated energy value of 282.5 kcal/100 g vs. 172.35 kcal/100g of product.

Also products from source E and from source C have showed significant differences: a fat content of 23.44% and 9.57% respectively, protein 19.43% versus 13.03%, water 61.25% vs. 67.89% and an

energy value of 270.77 kcal/100 g vs. 189.64 kcal/100g of product.

The same phenomenon was observed for products from source A and source D, they have very different proportions at the level of lipids (22.5% vs. 14.8%), of proteins (17.32% vs. 14.04%), water (57.34% vs 70.02%), but also of the energy value (280.66 kcal/100 g vs. 195.70 kcal/100 g).

The coefficient of variation (V%) of fresh sausages from **source A** has exceeded 10% at the level of lipid and collagen content, indicating a relative homogeneity of the product for these, and a very high homogeneity for the other components analyzed (Table 1).

Table 1 Chemical composition and energy value of fresh sausages from source A

Chemical components	$\bar{X} \pm S \bar{x}$	S ²	s	V%	Min.	Max.
Lipids%	22.50±1.57	3.52	12.36	15.63	18.80	25.90
Proteins%	17.32±0.43	0.96	0.92	5.53	16.40	18.60
Collagen%	2.66±0.13	0.29	0.09	11.04	2.38	3.01
Salt	1.82±0.07	0.15	0.02	8.15	1.60	2.00
Water%	57.34±1.23	2.76	7.62	4.82	54.70	60.20
Ash%	2.05±0.02	0.05	0.00	2.28	2.00	2.08
Dry matter%	42.66±1.23	2.76	7.62	6.47	39.80	45.30
OS%	39.82±1.16	2.59	6.71	6.50	36.90	42.30
NFEs%	0.97±0.18	0.41	0.17	4.13	0.40	1.35
EB kcal/100g	280.66±13.01	29.09	845.98	9.36	248.89	308.20
Kj	1174.28±54.42	121.69	14809.65	8.24	1041.34	1289.52

For **source B**, the coefficient of variation value demonstrates the inhomogeneity of the mixture at the NFEs level, exceeding the

threshold of 20% (Table 2) and a very high homogeneity for the other components analyzed.

Table 2 Chemical composition and energy value of fresh sausages from source B

Chemical components	$\bar{X} \pm S \bar{x}$	S ²	s	V%	Min.	Max.
Lipids%	22.65±0.46	1.11	1.24	4.92	21.50	24.00
Proteins%	17.15±0.10	0.24	0.06	1.42	16.90	17.40
Collagen%	2.62±0.03	0.08	0.01	3.01	2.54	2.70
Salt	3.43±0.08	0.19	0.03	5.42	3.20	3.70
Water%	56.43±0.36	0.88	0.78	1.56	55.60	57.50
Ash%	2.67±0.01	0.01	0.00	0.52	2.65	2.68
Dry matter%	43.35±0.36	0.88	0.78	2.04	42.50	44.40
OS%	39.80±0.36	0.87	0.76	2.20	38.90	40.90
NFEs%	1.28±0.25	0.61	0.37	47.63	0.40	1.90
EB kcal/100g	282.50±2.91	7.12	50.66	2.52	275.58	290.19
Kj	1181.98±12.16	29.78	886.81	2.52	1153.03	1214.16

The coefficient of variation calculated for sausages from **source C** demonstrates the inhomogeneity of the mixture at the salt level, this exceeding the 20% threshold, but

also a relative homogeneity for the content in lipids and ash and a very high homogeneity for the other components analyzed (Table 3).

Table 3 Chemical composition and energy value of fresh sausages from source C

Chemical components	$\bar{X} \pm S \bar{x}$	S ²	s	V%	Min.	Max.
Lipids%	13.03±0.68	1.66	2.75	12.73	11.10	15.80
Proteins%	16.03±0.54	1.32	1.74	8.22	14.20	17.90
Collagen%	2.93±0.03	0.08	0.01	2.78	2.90	3.10
Salt	1.23±0.17	0.41	0.17	33.10	0.40	1.40
Water%	67.89±0.86	2.10	4.41	3.09	64.35	69.99
Ash%	2.11±0.10	0.25	0.06	11.74	1.71	2.49
Dry matter%	32.11±0.86	2.10	4.41	6.54	30.01	35.65
OS%	30.00±0.82	2.02	4.06	6.72	28.30	33.50
NFEs%	0.93±0.19	0.46	0.21	9.64	0.50	1.50
EB kcal/100g	189.64±6.05	14.82	219.59	7.81	178.24	217.50
Kj	793.43±25.31	62.00	3844.12	7.81	745.75	910.00

For D source the value of the coefficient of variation demonstrates the inhomogeneity of the composition at salt level, ash and NFEs, exceeding the 20% threshold, for lipids, proteins and collagen had a relative homogeneity, exceeded 10% and for the other components analyzed a very high homogeneity (Table 4).

Table 4 Chemical composition and energy value of fresh sausages from source D

Chemical components	$\bar{X} \pm S \bar{x}$	S ²	s	V%	Min.	Max.
Lipids%	14.80±0.77	1.88	3.54	12.71	12.50	17.80
Proteins%	14.04±1.04	2.55	6.49	18.14	11.13	17.10
Collagen%	2.42±0.18	0.44	0.19	18.21	1.80	2.80
Salt	1.25±0.22	0.54	0.29	46.91	0.40	1.90
Water%	70.02±0.35	0.87	0.75	1.24	69.18	71.48
Ash%	1.14±0.09	0.23	0.05	20.32	0.72	1.42
Dry matter%	30.57±0.35	0.86	0.74	2.82	29.02	31.32
OS%	29.42±0.41	1.00	0.99	3.39	27.60	30.30
NFEs%	0.58±0.07	0.18	0.03	31.45	0.40	0.90
EB kcal/100g	195.70±3.39	8.30	68.92	4.24	187.70	211.56
Kj	818.80±14.18	34.73	1206.48	4.24	785.35	885.18

The coefficient of variation for sausages from **source E** exceeded the threshold of 20% at the level of salt content and SEN, demonstrating the inhomogeneity of the composition (Table 5), and at the level of protein content, collagen and ash the mixture had a relative homogeneity.

Table 5 Chemical composition and energy value of fresh sausages from source E

Chemical components	$\bar{X} \pm S \bar{x}$	S ²	s	V%	Min.	Max.
Lipids%	23.44±0.59	1.46	2.12	6.21	21.30	25.43
Proteins%	13.28±0.66	1.62	2.64	12.24	11.12	15.40
Collagen%	1.23±0.10	0.23	0.05	18.96	1.10	1.70
Salt	1.15±0.14	0.34	0.11	29.16	0.61	1.60
Water%	61.25±1.16	2.85	8.13	4.66	57.55	65.78
Ash%	1.35±0.10	0.23	0.06	17.37	1.10	1.80
Dry matter%	38.76±1.16	2.85	8.13	7.36	34.22	42.45
OS%	37.41±1.13	2.78	7.73	7.43	32.92	41.15
NFEs%	0.69±0.11	0.27	0.07	39.44	0.40	1.10
EB kcal/100g	270.77±7.40	18.12	328.34	6.69	241.54	296.14
Kj	1132.89±30.95	75.81	5747.84	6.69	1010.62	1239.06

The coefficient of variation for sausages from source F exceeds the 20% threshold for salt content this proves the inhomogeneity of the saltiness of the mixture and a very high homogeneity for the other components analyzed (Table 6).

Table 6 Chemical composition and energy value of fresh sausages from source F

Chemical components	$\bar{X} \pm S \bar{x}$	S ²	s	V%	Min.	Max.
Lipids%	9.57±0.16	0.37	0.61	6.35	8.90	10.50
Proteins%	19.43±0.05	0.04	0.20	1.00	18.60	20.40
Collagen%	3.70±0.02	0.00	0.06	1.54	3.34	3.78
Salt	0.48±0.14	0.26	0.51	47.00	0.30	0.90
Water%	68.65±0.13	0.25	0.50	0.72	64.90	70.20
Ash%	2.01±0.02	0.01	0.09	4.40	1.86	2.10
Dry matter%	31.35±0.13	0.25	0.50	1.64	29.80	31.10
OS%	29.00±0.13	0.23	0.48	1.70	27.77	29.00
NFEs%	0.74±0.14	0.27	0.52	4.14	0.10	1.55
EB kcal/100g	172.35±1.17	19.22	4.38	2.50	166.44	184.21
Kj	721.13±4.90	336.41	18.34	2.50	613.13	770.72

The statistical significance of the differences of chemical composition and energy value of fresh sausages studied (from sources A, B, C, D, E, F) are presented in next table (tab. 7).

Table 7 The statistical significance of the differences on chemical composition and energy value of fresh sausages studied

ANOVA Multiple comp. test	Lipids		Proteins		Collagen		Salt		Water		Ash		NFEs%		GE kcal/100g	
	S	P Value	S	P Value	S	P Value	S	P Value	S	P Value	S	P Value	S	P Value	S	P Value
A-B	ns	>0.9999	ns	>0.9999	ns	0.9995	***	<0.0001	ns	0.9825	***	<0.0001	ns	0.8618	ns	0.9996
A-C	***	<0.0001	ns	0.5498	ns	0.3047	ns	0.2183	***	<0.0001	ns	0.5205	ns	>0.9999	***	<0.0001
A-D	***	<0.0001	**	0.0016	ns	0.4310	ns	0.1150	***	<0.0001	***	<0.0001	ns	0.7233	***	<0.0001
A-E	ns	0.9364	***	<0.0001	***	<0.0001	ns	0.1166	**	0.0052	**	0.0012	ns	0.9110	ns	0.8410
A-F	***	<0.0001	**	0.0014	***	<0.0001	*	0.0231	***	<0.0001	ns	0.8904	ns	0.9822	***	<0.0001
B-C	***	<0.0001	ns	0.6453	ns	0.1360	***	<0.0001	***	<0.0001	**	0.0010	ns	0.7642	***	<0.0001
B-D	***	<0.0001	**	0.0017	ns	0.5831	***	<0.0001	***	<0.0001	***	<0.0001	ns	0.1061	***	<0.0001
B-E	ns	0.9623	***	<0.0001	***	<0.0001	***	<0.0001	***	0.0004	***	<0.0001	ns	0.2378	ns	0.6279
B-F	***	<0.0001	***	0.0003	***	<0.0001	***	<0.0001	***	<0.0001	***	<0.0001	ns	0.2859	***	<0.0001
C-D	ns	0.4551	ns	0.0910	**	0.0022	ns	0.9993	ns	0.2595	***	<0.0001	ns	0.7642	ns	0.9722
C-E	***	<0.0001	**	0.0067	***	<0.0001	ns	0.9994	***	<0.0001	***	<0.0001	ns	0.9384	***	<0.0001
C-F	**	0.0017	***	<0.0001	***	<0.0001	ns	0.9826	ns	0.2822	ns	0.9125	ns	0.9924	ns	0.3155
D-E	***	<0.0001	ns	0.8989	***	<0.0001	ns	>0.9999	***	<0.0001	ns	0.5083	ns	0.9983	***	<0.0001
D-F	***	<0.0001	***	<0.0001	***	<0.0001	ns	0.9998	ns	0.9974	***	<0.0001	ns	0.9117	ns	0.0518
E-F	***	<0.0001	***	<0.0001	***	<0.0001	ns	0.9997	***	<0.0001	***	<0.0001	ns	0.9950	***	<0.0001

The results obtained in this study with regard to the chemical composition of fresh sausages can be compared with those presented by Monteiro et al., 2017 in a study in fresh Toscana sausages nutritive value (moisture 59.19 %, crude proteins 15.95 %, lipids 21.83 % and ash 1.95%). In the same interval have been framed and determinations made by Oliviera Faria et al. 2015 (moisture 60.16%, proteins 16.17% lipids 21.48%, and yet with more ash 3.63%). Similar values have

been also determined by De Marchi et al., 2017: moisture 64.98 %, protein 17.75 %, lipids 13.95 % and Na 0.39% for mixes composed of muscle meat (bovine, pork, turkey, chicken and duck) with varying quantities of animal fat; non-meat ingredients are added in smaller quantities for improvement of flavor and binding (for minced meat, hamburgers, meat balls, sausages, zampone, cotechino and tastasale) showing the high variability of these products.



The highest amount of salt was determined for sausages from source B (3.43%) being the only one of the six analyzed assortments that did not have nutritional labeling. The new European Regulation 1169/2011 (De Marchi et al., 2017), which establishes the general principles, requirements and responsibilities governing food information and in particular food labelling, requires "salt" content to be added to the mandatory nutrition declaration of food products instead of "sodium". However, it defines "salt" as $\text{Na} \times 2.5$ which

is obtained from the proportion of NaCl (40:60). After Desmond, 2006, NaCl is the main provider of Na (79%) in processed meat, there are other ingredients that could influence Na content (e.g., sodium tripolyphosphate, sodium nitrite, sodium ascorbate or erythorbate, sodium nitrite).

The nutritional-economic characterization of the studied products was followed by the comparison of their price and the quantity of water, protein, fat and energy received by the consumer for a value unit (1 RON) (Table 8).

Table 8 Nutritional - economic characteristics of fresh sausages

Nutritional - economic characteristics		Fresh sausages						Average A-F
		A	B	C	D	E	F	
Price	RON/ kg	17.9	13.49	15.99	16.99	17.99	18.99	16.89
Protein	g / kg	173.2	171.5	160.3	140.4	132.8	201.7	163.3
	g / RON	9.68	12.71	10.03	8.26	7.38	10.62	9.67
Fat	g / kg	225.0	226.5	130.3	148.0	234.4	95.7	176.7
	g / RON	12.57	16.79	8.15	7.67	7.24	6.86	7.71
Energy	GE kcal / kg	280.66	283.20	189.64	195.70	270.77	175.59	232.59
	kcal /RON	17.90	13.49	15.99	16.99	17.99	18.99	16.89
Water	g / kg	573.4	566.5	678.9	700.2	612.5	696.5	638.0
	g / RON	32.03	42.51	35.86	33.75	31.87	30.19	33.95

Thus, even if the prices for one kg of fresh sausages do not differ greatly much (13.5-19 RON/ kg), the amount of fat offered to consumers for 1 RON is more than double for product B (16.79 g), compared to product F (6.86 g) and implicitly the number of calories is higher (283.6 kcal for B product vs. 175.59 kcal).

The product B can be considered to be energetically unbalanced (hypercaloric) and this fact can also be related to the lack of nutritional information on the product label. The consumer should be fair and fully informed so that they can reasonably choose the product they prefer.

The average of the price was 16.89 RON/kg and in this price too many fats are included for source B (226.5 g/kg) and A (225.0 g/kg) and a low level of protein for sources D (140.4 g/kg) and E (132.8 g/kg), instead the amount of water was quite high for them (700.2 g/kg and respectively 621.5 g/kg); on average, for all producers, the amount of water was 638.0 g/kg.

CONCLUSIONS

Following the determinations made, at the level of chemical composition and energy value of the fresh sausages analyzed, the lipids and water content has varied the most, with differences of 138.7 g/kg and respectively, with differences of 133.7 g/kg, and the protein content had lower variations, with differences of 61.5 g/kg; the energy value was higher with differences of 1101.5 kcal/kg for the six sources of fresh sausage studied. The highest amount of salt was determined for sausages from source B (3.43%), being the only one that did not have nutritional labelling.

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