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SENSORY QUALITY AND SELECTED PHYSICOCHEMICAL PROPERTIES OF PROCESSED MEAT PRODUCTS PRODUCED IN DIFFERENT PLANTS

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Abstract. The purpose of the study was to assess chemical composition, colour and sensory properties of processed meat products: pork ham, "Parówkowa" sausage, "Śląska" sausage and "Krakowska" dry sausage produced without compatibility declaration with Polish Norm in three meat processing plants situated in different regions of Poland. There were determined in our studies content of protein, fat, NaCl, water, free nitrate (III), added polyphosphates and also some parameters of sensory assessment like taste, smell, juiciness and texture. It was concluded that the investigated processed meat products had good nutritive value, similar sensory quality and colour stability. They were also safe in context of free nitrate (III) and added polyphosphates contents. There was compliance of the investigated processed meat products with Polish Norm PN-A-82007 [1996] although no declaration of compliance was printed on the labels.

Key words: quality of processed meat products, chemical composition, residues, colour, sensory analysis

INTRODUCTION

Many Polish meat processing plants produce their products according to Polish Norms although there is no obligation to use them. Range of products manufactured in compliance with Polish Norms are treated by consumers as products with high sensory quality, balanced chemical composition and good nutritive value. Nevertheless many meat products are produced according to inner plant standards what sometimes lead to its lower quality not accepted by consumers. There is no obligation to indicate chemical composition on food labels, so Good Manufacturing Practice (GMP) is one of the factors influencing the producers to keep good quality of their products. Assessment, veri-

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fication and normalization of the processed meat products is more and more important on local, domestic and international markets [Nowicki 1984, Incze 1992, Konopka and Pełczyńska 1994, Białasiewicz and Królasik 2002, Ambrosiadis et al. 2004].

Selected properties of some processed meat products sold on the Wrocław local market were analysed in our studies. The purpose of the work was the assessment of physicochemical and sensory properties of processed meat products made in different plants and investigation of relationship between analysed parameters.

MATERIAL AND METHODS

Processed meat products from three different meat plant located in the Lower Silesia province (I), Łódź province (II) and Podlasie province (III) were subject of the study. Products were obtained in three different series within two weeks of difference among them. Processed meat products were bought in firm shops situated at shopping malls in Wrocław.

The next processed meat products were analysed in our studies: "Parówkowa" sausage (P), "Śląska" sausage (S), "Krakowska" dry sausage (K), cooked scalded pork ham (H). Products were belonging to two technological groups (smoked hams, sausages) and four assortments (cooked pork ham "H", homogenized processed meat products – "Parówkowa" sausage "P", semi coarse ground sausage – "Śląska" sausage "S", coarse ground sausage – "Krakowska" dry sausage "K". All four assortments with the same product names on labels were taken from three investigated meat plants.

The next physicochemical analyses were performed: pH value, content of protein, fat, NaCl, water, free nitrate (III) and added polyphosphates. The pH values were determined using a Microcomputer CP-551. Content of protein in the analysed processed meat products was determined using Kjeldahl method according to Polish Norm PN--75/A-04018 where conversion rate of nitrogen into protein was N × 6.25. Content of NaCl was analysed and calculated using Mohr method (PN-73/A-82112). Dry matter was determined using Polish Norm PN-73/A-82110 and content of fat was calculated using Soxhlet method (PN-73/A-82111). Free nitrate (III) and polyphosphates were determined according to PN-74/A-82114 and PN-A-82060 [1999], respectively. Added phosphorus was calculated as the difference between the total amount of phosphorus and physiological phosphorus [PN-A-82060 1999].

Colour parameters of processed meat products were recorded in L*, a*, b* system using a CR-200b reflection colorimeter (Minolta). Measurements were carried out on the cut of 10 mm slices of vacuum packed products in PA20/PE80 bags. Colour stability was determined according to changes of colour parameters (L*, a*, b*) of vacuum packed slices after 3, 6 and 24 h of exposure to white glow light (250 lx). The stability of colour was calculated according to the following formula:

$$\Delta E_X = \sqrt{\Delta(L_o^* - L_x^*)^2 + \Delta(a_o^* - a_x^*)^2 + \Delta(b_o^* - b_x^*)^2}$$

where:

ΔE_X (means ΔE_3 or ΔE_6 or ΔE_{24}) – stability of colour after 3, 6 or 24 h of processed meat products slices exposure to light,

L_o*, a_o*, b_o* – values of colour parameters L*, a*, b* of processed meat products slices with no exposure to light,

L_x*, a_x*, b_x* – values of colour parameters L*, a*, b* of processed meat products slices after 3, 6 or 24 h exposure to light.

Larger ΔE_X value means larger colour changes what is equal to smaller colour stability.

Sensory evaluation was carried out using score assessment [PN-ISO 6658 1998]. Five points scores of intensity and desirability scales were used in the experiment. There was from 1 point (very slight) to 5 point scores of intensity (very strong) and similar for desirability: from 1 point (undesirable) to 5 point scores (very much desirable). All processed meat products were sensory investigated by six persons panel. Products were prepared as half of chubs and 2.5 mm slices and presented to panellists on disposable dishes in white glow light (250 lx). The next sensory parameters were investigated: 1 – appearance, 2 – tenderness, 3 – juiciness, 4 – colour, 5 – flavour, 6 – smell, 7 – saltiness, 8 – total assessment. For parameters 4, 5, 6 and 7 both intensity and desirability scales were used.

Statistical analysis of the results was carried out using STATISTICA 5.0 software where averages, standard deviations, least significant differences and estimation of differences between mean values at $p < 0.05$ were calculated.

RESULTS AND DISCUSSION

Measured values of pH were characteristic for immature processed meat products [Ambrosiadis et al. 2004]. The highest values of pH were determined for products obtained from plant number III (Table 1). Chemical substances added during curing were probably not the reason of high values of pH in the investigated products, because there was neither a high level of both sodium chloride nor polyphosphates in them, but intensive heat treatment, which usually increases pH values in meat products, could be the main reason. Products were characterized by higher stability and lower probability of storage acidulation. That fact was probably the result of efficacious thermal treatment of the investigated products. Good quality raw material without PSE defect could resulted in high pH value of ham. Meat plant number III put into practice HACCP system which could be another reason for high pH of ham. Different assortments were characterized by different pH values. Homogeneity of that parameter occurred inside of the next product groups: ham (H), "Parówkowa" sausage (P) and "Śląska" sausage (S), but usually for products obtained not more that from 2 meat plants. Low pH value of "Krakowska" dry sausage (K) was confirmed in previous studies [Szmańko et al. 2003 a, c].

The highest protein content was for "S" and "P" products manufactured in meat plant number I. The highest significant difference for protein content occurred in "Śląska" sausage assortment. There was no significant difference for products (in another assortments) at least from 2 meat plants. Protein content of the investigated products was on correct level according to Polish Norm PN-A-82007 [1996], but discussed assortment produced only by plant number II met requirements of Polish Norm PN-A--82025 [2001] for "Krakowska" sausage as regional product.

Table 1. Chemical composition of processed meat products (n = 10)
Tabela 1. Skład chemiczny wędlin (n = 10)

Assortment Sortyment	Plant Zakład		pH	Total protein Białko ogółem %	Total fat Tłuszcz ogółem %	NaCl Sól %	Water Woda %	Free nitrate (III) Wolne azotany (III) ppm	Added poly-phosphates Fosfor dodany ppm P_2O_5
Cooked pork ham Szynka gotowana (H)	I	X	6.04a*	17.55b	7.21c	3.59c	72.07a	75.79c	3 601.25a
		sd	0.05	0.71	0.70	0.27	0.46	2.01	117.44
	II	X	6.07a	15.58a	5.62b	3.34b	78.05c	44.44a	4 032.78b
		sd	0.05	0.90	0.71	017	0.57	2.65	92.28
	III	X	6.36b	16.13a	3.83a	3.00a	76.97b	60.72b	3 885.32b
		sd	0.09	0.93	0.50	0.24	1.77	1.74	247.92
"Parówkowa" sausage Kiełbasa parówkowa (P)	I	X	6.03b	11.29b	34.70a	2.06a	52.40b	36.80b	–
		sd	0.05	0.55	1.55	0.19	1.66	1.11	–
	II	X	5.78a	9.47a	37.27b	2.44b	54.15c	32.57a	–
		sd	0.26	0.33	0.80	0.25	0.25	4.12	–
	III	X	6.08b	9.95a	36.86b	2.40b	50.38a	56.31c	–
		sd	0.10	1.44	0.78	0.22	0.87	1.18	–
"Śląska" sausage Kiełbasa śląska (S)	I	X	5.90a	15.79b	15.61a	2.62a	65.95b	55.57b	0.00a
		sd	0.00	0.49	2.07	0.26	2.39	1.35	0.00
	II	X	5.89a	16.54c	26.61c	3.25b	58.36a	50.18a	875.63b
		sd	0.14	0.68	1.26	0.18	3.44	1.47	86.37
	III	X	6.08b	11.84a	19.81b	2.58a	66.15b	59.61c	0.00a
		sd	0.10	0.30	0.59	0.09	0.80	2.24	0.00
"Krakowska" sausage Kiełbasa krakowska (K)	I	X	5.60a	19.51a	20.94c	3.31a	56.59b	63.73b	0.00a
		sd	0.08	0.96	0.82	0.25	2.06	1.50	0.00
	II	X	5.77b	21.95b	16.95a	3.75b	57.37b	63.69b	827.61b
		sd	0.12	0.92	1.56	0.12	2.10	1.37	98.19
	III	X	5.87c	19.48a	18.61b	3.74b	54.76a	51.28a	137.51c
		sd	0.05	1.36	0.35	0.21	0.56	1.53	221.56

X – average, sd – standard deviation. Means marked with different letters are significantly different within the columns and the same assortments at $p \leq 0.05$.

X – średnia, sd – odchylenie standardowe. Średnie oznaczone tym samym indeksem literowym oznaczają brak istotnej różnicy przy $p \leq 0,05$.

The fat was the most labile component of processed meat products. The lowest level of fat was determined in cooked pork ham (from 3.83% to 7.21%). Phenotype diversification of pigs was the most probable reason of different level of intermuscular fat content in hams. Total content of fat in investigated products met the requirements of Polish Norm PN-A-82025 [2001].

The highest level of fat was determined in "Parówkowa" sausage (P) and "Śląska" sausage (S), both products obtained from meat plant in Łódź region (II). The high diversification of fat in semi coarse ground sausages was observed. The lowest level of fat was in products from the meat plant located in Lower Silesia region (I), because there was 27% of fat more in "Śląska" sausage from Łódź region (II) and 70% more in products from Podlasie region (III). Nevertheless "Śląska" sausage could be characterized as a low fat product. The content of fat in products from meat plants I and II was low, i.e. on 50% level accepted by Polish Norm. There was high diversification in fat content observed in "Krakowska" sausage. Technologies with minimized fat content in final products are highly recommended in meat industry [Kostyra and Olkiewicz 1999, Cierach and Szaciło 2003, Caceres et al. 2004]. Presented results confirm that trend in some aspects.

There was from 3.00% to 3.59% of sodium chloride in cooked pork ham (H), which correspond to 70-90% of the accepted NaCl content in such products by requirements of Polish Norm. Sodium chloride content was on 70-80% level accepted by PN in "Parówkowa" sausage (P) and on 82-93% level in "Krakowska" sausage products (K). There was exceeding of sodium chloride content by 8% in "Śląska" sausage products (S) obtained from meat plant number II.

Sodium chloride is an important factor not only from the technological point of view, but also for its role in sensory characteristic of final products [Baryłko-Pikielna 1988, Makała 1997, Ambrosiadis et al. 2004, Andreas et al. 2004]. Nevertheless the total level of NaCl in food products should be lowered because of human health reasons [Baryłko-Pikielna and Jawor-Kulesza 1993, Kozłowska-Wojciechowska 1992]. That trend is also observed for Polish meat products where NaCl content was lowered in years 1994-1999 by 0.6% in hams, by 0.45% in durable sausages and by 0.25% in non-durable sausages [Kłossowska 1999].

The highest diversification of water content was observed for ham (72.07-78.05%) and for "Śląska" sausage (58.36-66.15%) but all assortments met the requirements of Polish Norm PN-A-82007 [1996]. From the other point of view "Krakowska" sausages (K) produced in meat plant number I and II did not meet the requirements of another Polish Norm establish just for "Krakowska" sausages [PN-A-82025 2001].

All products met the requirements of free nitrates(III) content [Dziennik Ustaw... 2004]. Trends of lowering that ingredient in meat products are observed not only abroad, but also in Polish plants [Majchrzak 1985, Baryłko-Pikielna and Jawor-Kulesza 1993, Cassens 1995 a, b, Kłossowska 1999, Dziennik Ustaw... 2004].

Amount of phosphates was on a safe level in the investigated meat products [Dziennik Ustaw... 2004]. The highest level of phosphates was determined in the ham. There was no added phosphates in "Parówkowa" sausage. It is hard to explain polyphosphates additives in "Krakowska" sausages found in products of meat plants number II and III. Probably cured semi-product used in production of "Krakowska" sausage was treated as universal material prepared also for another assortments production. The lowering of P_2O_5 level in Polish meat products was observed in years 1994-1999 [Kłossowska 1999]. Our results have not confirmed that trend which could be negative for human health [Słowiński and Jankiewicz 1995, Starzyński and Masłowska 1995, Kłossowska 1999].

Table 2. Sensory analysis of processed meat products (points: 1 – minimum, 5 – maximum; n = 10)
Tabela 2. Ocena sensoryczna wędlin (punkty: 1 – minimalna, 5 – maksymalna; n = 10)

Assortment Sortyment	Plant Zakład		Appearance Wygląd zewnętrzny	Colour intensity Barwa natężenie	Colour desirability Barwa pożądal-ność	Smell intensity Zapach natężenie	Smell desirability Zapach pożądal-ność	Juiciness Soczystość	Texture tenderness Tekstura kruchość	Flavour intensity Smako-witość natężenie	Flavour desirability Smako-witość pożądal-ność	Salty taste intensity Słoność natężenie	Salty taste desirability Słoność pożądal-ność	General evaluation Ocena ogólna
Cooked pork	I	X	4.77b	4.84b	4.70	4.71	4.60	4.62	4.65	4.67	4.67	4.60b	4.70	4.68
ham		sd	0.25	0.14	0.38	0.29	0.37	0.32	0.40	0.37	0.38	0.35	0.42	0.34
Szynka	II	X	4.61b	4.66ab	4.81	4.40	4.57	4.53	4.57	4.44	4.45	4.44ab	4.80	4.62
gotowana		sd	0.38	0.30	0.23	0.37	0.42	0.36	0.33	0.32	0.44	0.33	0.35	0.27
(H)	III	X	4.37a	4.43a	4.50	4.51	4.33	4.62	4.36	4.56	4.33	4.33a	4.79	4.47
		sd	0.45	0.37	0.49	0.34	0.45	0.29	0.53	0.37	0.58	0.24	0.27	0.35
"Parówkowa"	I	X	4.48	4.61	4.50	4.74	4.60	4.49	4.52	4.65	4.50	4.74	4.68	4.54
sausage		sd	0.29	0.28	0.29	0.30	0.57	0.55	0.41	0.27	0.55	0.29	0.53	0.43
Kiełbasa	II	X	4.36	4.39	4.46	4.51	4.37	4.33	4.65	4.38	4.17	4.46	4.88	4.46
parówkowa		sd	0.70	0.59	0.60	0.41	0.79	0.66	0.37	0.30	0.75	0.33	0.20	0.49
(P)	III	X	4.72	4.41	4.42	4.65	4.68	4.69	4.68	4.47	4.59	4.47	4.81	4.66
		sd	0.22	0.40	0.53	0.34	0.35	0.33	0.34	0.29	0.34	0.39	0.22	0.17
"Śląska"	I	X	4.60	4.61	4.29a	4.66	4.59	4.63	4.53	4.68	4.43	4.69	4.88	4.56
sausage		sd	0.29	0.58	0.74	0.37	0.60	0.59	0.54	0.39	0.76	0.39	0.26	0.46
Kiełbasa śląska	II	X	4.63	4.72	4.86b	4.49	4.50	4.50	4.51	4.50	4.49	4.50	4.80	4.61
(S)		sd	0.40	0.31	0.20	0.37	0.45	0.32	0.40	0.37	0.46	0.27	0.35	0.26
	III	X	4.56	4.54	4.66ab	4.46	4.47	4.34	4.53	4.52	4.74	4.40	4.87	4.59
		sd	0.25	0.35	0.25	0.30	0.34	0.28	0.33	0.34	0.28	0.32	0.21	0.13
"Krakowska"	I	X	4.60	4.57	4.59	4.33	4.55	4.51	4.75	4.43	4.83	4.49	4.93	4.68
sausage		sd	0.36	0.35	0.48	0.55	0.65	0.32	0.32	0.36	0.24	0.44	0.16	0.32
Kiełbasa	II	X	4.74	4.74	4.87	4.49	4.55	4.54	4.61	4.44	4.71	4.41	4.90	4.70
krakowska		sd	0.31	0.32	0.17	0.37	0.42	0.39	0.43	0.32	0.30	0.31	0.21	0.24
(K)	III	X	4.68	4.53	4.59	4.58	4.62	4.58	4.66	4.55	4.76	4.45	4.77	4.66
		sd	0.30	0.28	0.30	0.37	0.38	0.34	0.34	0.34	0.23	0.37	0.25	0.16

Footnotes see Table 1.
Oznaczenia jak w tabeli 1.

The highest value of L* parameter of colour was measured for hams produced in meat plant number II (Table 3). Meat products colour is mainly affected by haem pigment content in meat volume. Amount of haem pigment is influenced also by increasing of processed product yield or higher fat content. The obtained results confirm theoretical aspects of meat products colour. The highest values of lightness were measured for high yield hams produced by plant number II. Meat products placed on the second position according to lightness had the highest level of intermuscular fat. Smoked product were characterized by the darkest colour (low L* value) and the highest value of a* parameter which was influenced by haem pigment content.

Table 3. Colour of processed meat products (L*, a*, b*; n = 10)
Tabela 3. Barwa wędlin w skali L*, a*, b*; n = 10)

Assortment Sortyment		L*			a*			b*		
		Plant – Zakład								
		I	II	III	I	II	III	I	II	III
Cooked pork ham Szynka gotowana (H)	X	63.87	66.40	62.98	10.53	10.53	11.89	5.23a	6.72b	7.26b
	sd	4.37	2.92	4.75	1.43	2.11	3.02	0.53	0.72	0.89
"Parówkowa" sausage Kiełbasa parówkowa (P)	X	61.46a	64.27b	69.59c	14.84c	13.20b	10.95a	12.08a	13.90b	12.53a
	sd	1.98	2.63	0.52	0.75	2.69	0.69	0.88	0.35	0.43
"Śląska" sausage Kiełbasa śląska (S)	X	52.13a	60.39b	63.27b	17.53c	12.79b	10.72a	8.30	8.76	8.14
	sd	3.96	2.82	3.29	2.15	1.61	1.64	0.61	1.58	0.92
"Krakowska" sausage Kiełbasa krakowska (K)	X	60.90b	59.20ab	57.42a	12.90	14.57	13.34	7.42	7.93	8.25
	sd	2.78	4.20	3.81	1.35	2.68	2.06	1.60	1.41	0.89

Footnotes see Table 1.
Oznaczenia jak w tabeli 1.

There were not statistically significant differences for L* and a* parameter (separately) of produced hams, but differences for b* parameter were found between products from meat plant number I (the lowest b* value) and plants number II and III. The stability of colour after 6 h of exposure to white glow light was similar in hams (Table 4). Extending of exposure time resulted in similar stability of colour for smoked products manufactured in plants number I and III, and significant lower stability for products of plant number II. These cooked ham were also characterized by the lowest content of free nitrates (III).

Table 4. Colour stability of processed meat products after 3, 6 and 24 hours of exposure to white glow light (ΔE_3, ΔE_6, ΔE_{24}; n = 10)
Tabela 4. Trwałość barwy wędlin po 3, 6 i 24 h ekspozycji na światło szare (ΔE_3, ΔE_6, ΔE_{24}; n = 10)

Color stability Trwałość barwy	Plant Zakład	Assortment – Sortyment			
		Cooked pork ham Szynka gotowana (H)	"Parówkowa" sausage Kiełbasa parówkowa (P)	"Śląska" sausage Kiełbasa śląska (S)	"Krakowska" sausage Kiełbasa krakowska (K)
ΔE_3	I	1.73	1.42	1.26	1.17b
	II	1.28	2.18	1.80	0.63a
	III	1.37	1.30	2.11	1.22b
ΔE_6	I	2.43	1.72	1.34a	1.82
	II	1.99	2.49	1.71a	0.88
	III	1.86	1.48	2.70b	1.48
ΔE_{24}	I	2.38a	1.88ab	1.70a	3.29b
	II	3.35b	3.49b	3.11ab	2.05ab
	III	2.06a	1.43a	3.66b	1.49a

Means marked with different letters are significantly different within the columns (separately for ΔE_3, ΔE_6, ΔE_{24}) and the same assortments at $p \leq 0.05$.

Średnie oznaczone tym samym indeksem literowym oznaczają (osobno dla ΔE_3, ΔE_6, ΔE_{24}) brak istotnej różnicy przy $p \leq 0,05$.

Diversification of colour was higher in the investigated products where higher grinding of batter occurred. Mentioned regularity was observed for "Parówkowa" sausages (P), "Śląska" sausages (S) and "Krakowska" sausages (K) for the next parameters of colour: L*, a*, b* (P); L*, a* (S) and L* (K), respectively. There was no relationship between chemical composition and stability of colour. Nevertheless, interrelation trend between free nitrates (III) and stability of "Parówkowa" sausages colour was observed (Fig. 1). Lower changes of colour parameters after exposure to light were noticed for products with higher level of free $NaNO_2$. This trend was characteristic and confirmed for all periods of light exposure. That observation can be theoretically explained. The excess of nitrates (III) during meat curing is a reason for better haem pigment reactions. The higher level of haem pigment in final product can better prevent from undesirable colorants oxidation. Such regularity was the mostly observed for "Parówkowa" sausages (P) what could be explained by the high homogeneity of that product. All theoretical regularities have probably the greater chance to occur in homogenized products where equalization of chemical composition is higher.

The low stability of "Parówkowa" sausages and its short shelf-life could be also another reason of the observed relation between the level of free nitrates (III) and stability of colour in that sausage which was not observed for others sausages. The lowering of free nitrates (III) level in sausages is generally observed during their storage [Szmańko et al. 2003 a, c]. Relationship between stability of colour and level of free nitrates (III)

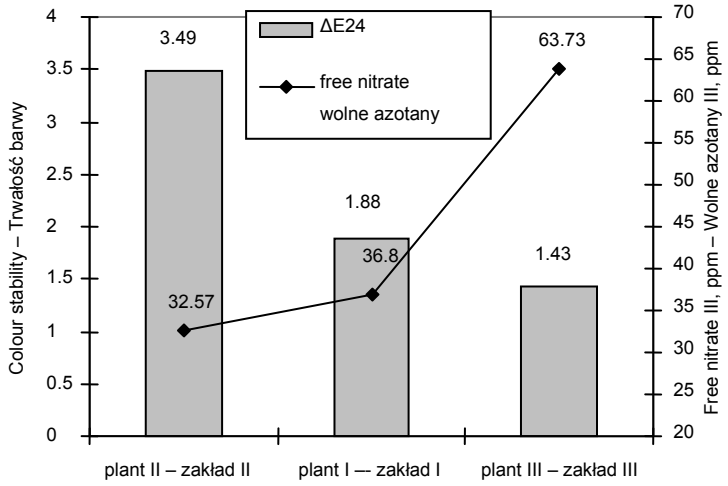

Fig. 1. Effect of free nitrate (III) content on colour stability (ΔE_{24}) of "Parówkowa" sausage
Rys. 1. Wpływ wolnych azotanów (III) na trwałość barwy (ΔE_{24}) kiełbasy parówkowej

in more durable sausages was difficult or even impossible for determination. Such products were probably stored during the longer time before our studies, so storage reduction of free nitrates could took place.

There were no statistical differences of appearance of the investigated sausage surfaces in sensory evaluation tests and scores were between 4.5 and 4.7 points (Table 2). Only hams from meat plant number III were characterized by lower assessment of that parameter comparing to products from plants number I and II. There is a relation between high score of sausages surface appearance and their flavour [Ambrosiadis et al. 2004]. Intensity of colour was high, i.e. from 4.39 points (for "Parówkowa" sausage obtained from plant number II) to 4.84 points ("Śląska" sausage from plant number I).

There were also observed high and similar scores for desirability of sausages colour. The only statistically differences was found between "Śląska" sausage obtained from meat plant number I and II.

The highest scores of intensity and desirability of sausages colour were obtained for products from meat plant number I. The second high scores were noticed for products of plant number III, and the last ones were from plant number II.

Trend of higher desirability between ham colour produced in meat plant number II and higher value of L* parameter was observed. High desirability of "Parówkowa" sausages colour obtained from plant number I was connected with lower lightness (L*) of these sausages, higher value of a* and lower of b* parameters. High desirability of "Śląska" sausage was characteristic for products with medium values of lightness and a* colour parameter. Colour of "Krakowska" sausage was the most desirable for products with medium values of L* and b* parameters, but also with high values of a* parameter.

Both intensity and desirability of smell for selected assortments processed meat products produced in three comparable plants were characterized by similar scores, i.e.

a little above 4.5 points. Differences of meat products smell intensity for the investigated plants was not statistically significant. The highest smell desirability, like for intensity, was noticed for the products obtained from meat plants I and III, where scores were identical, i.e. 4.6 points. The highest notes for intensity and desirability of smell were noticed in ham and "Krakowska" sausage products with the lowest content of water.

There was no differences for juiciness in the investigated assortments of processed meat products for all plants. Average values of juiciness for 4 products obtained from plants I and III were almost the same, i.e. 4.55 points which was a little higher comparing the value of products from plant number II (4.47 points). There was no effect of water content in the processed meat products on their juiciness.

The investigated products were grouped as homogenous groups inside selected assortments, where texture was taking into account. Average score of texture was a little above 4.5 points and products from the meat plants obtained 4.61 points (for plant I), 4.58 points (II) and 4.55 points (III). Hams and "Parówkowa" sausages with lower water content were characterized by higher scores of tenderness and texture.

The most of products from meat plant number I, i.e. hams, "Parówkowa" sausages and "Śląska" sausages, were classified above 4.6 points for intensity of flavour. Only "Krakowska" sausage from this plant with score of 4.43 points was exception. Products from plant number II located in Podlasie Province obtained the lowest scores for flavour. Higher intensity and desirability of flavour for hams and "Krakowska" sausages, which have usually lower water content, were characterized similarly as during assessment of intensity and desirability of smell.

There were only statistically significant differences between scores of saltiness in hams produced in plants I (4.60 points) and plant II (4.33 points). No statistically significant differences were found for the other assortments and obtained results were about 4.50 points. Average value 4.8 points for saltiness desirability of investigated products was one of the highest evaluated sensory parameter. There were no differences within the investigated assortments. The lower NaCl content in cooked hams and "Parówkowa" sausages was the probable reason of higher scores of their saltiness desirability.

Average values of total sensory assessments of four assortments confirmed the high equalization of sensory evaluation for products produced in the investigated meat plants where the next scores were obtained: 4.61 (plant I), 4.59 (II) and 4.59 (III). Scores of sensory evaluation are similar to our earlier studies and other authors' investigations [Szmańko 1998, Dzieszuk et al. 2003, Szmańko et al. 2003 a, b, c, 2004].

CONCLUSIONS

1. Almost all investigated assortments of processed meat products met requirements of Polish Norm [PN-A-82007 1996] for protein content. Meat products were characterized with similar fat content, but the trend of its slight lowering comparing to Polish Norm was observed.

2. There was no exceeding of maximum limit of water content [PN-A-82007 1996], nevertheless pork ham and "Krakowska" sausage were close to exceed those water limits.

3. There was no exceeding of maximum limit of safe level of free nitrate (III) and added phosphates in the investigated products.

4. The highest colour diversification of the processed meat products was noticed for "Parówkowa" and "Śląska" sausages. There were fewer differences of colour stability for pork hams than for sausages.

5. The trend of simple correlation between colour stability of "Parówkowa" sausages and free nitrates level in them was observed.

6. The investigated processed meat products were characterized by a high sensory quality and there were almost no differences among them.

7. Processed meat products produced in different regions of Poland met requirements of Polish Norm PN-A-82007 [1996] although there was no declaration of these requirements on product labels. The investigated products were characterized by high and equal sensory quality and residues in them were on safe level.

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JAKOŚĆ SENSORYCZNA ORAZ WYBRANE WŁAŚCIWOŚCI FIZYKOCHEMICZNE WĘDLIN WYPRODUKOWANYCH W WARUNKACH RÓŻNYCH ZAKŁADÓW MIĘSNYCH

Streszczenie. Porównano skład chemiczny, barwę i cechy sensoryczne wędlin: szynki wieprzowej, kiełbasy parówkowej, śląskiej i krakowskiej suchej, wyprodukowanych bez deklarowanej zgodności z polską normą w trzech zakładach mięsnych zlokalizowanych w różnych regionach kraju. Na podstawie oznaczonych zawartości białka, tłuszczu, NaCl, wody, wolnych azotanów (III), polifosforanów dodanych oraz wyróżników barwy (L*, a*, b*), a także oceny smaku, zapachu, soczystości i tekstury stwierdzono, że badane wędliny charakteryzują się dobrą wartością odżywczą, wysoką, wyrównaną jakością sensoryczną i podobną trwałością barwy oraz są bezpieczne ze względu na zawartość wolnych azotanów (III) i dodanego fosforanu. Badane wędliny spełniały wymogi normy, pomimo że na ich opakowaniu nie była deklarowana zgodność z wymaganiami PN-A-82007 Przetwory mięsne [1996].

Słowa kluczowe: jakość wędlin, skład chemiczny, pozostałości, barwa, ocena sensoryczna

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