Dr hab. Krzysztof DASIEWICZ
Dr hab. Aneta CEGIEŁKA
Prof. dr hab. Mirosław SŁOWIŃSKI
Division of Meat Technology, Department of Food Technology and Evaluation, Institute of Food Sciences
Warsaw University of Life Sciences (SGGW – WULS), Poland
Zakład Technologii Mięsa, Katedra Technologii i Oceny Żywności, Instytut Nauk o Żywności
Szkoła Główna Gospodarstwa Wiejskiego w Warszawie, Polska

AN ATTEMPT TO USE VARIOUS FAT RAW MATERIALS IN THE PRODUCTION OF HOMOGENIZED SAUSAGES®

Próba wykorzystania zróżnicowanego surowca tłuszczowego w produkcji kiełbas homogenizowanych®

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Key words: pork back fat, beef tallow, goose fat, homogenized sausage, quality features.

The aim of the research was an attempt to use various fat raw materials in the production of homogenized scalded sausages and to evaluate their effect on the quality features of sausages. The experimental material was homogenized scalded sausages produced with the addition of pork jowl, pork back fat, beef tallow and goose fat. The analytical part of the work included the analysis of the chemical composition, the measurement of color and texture parameters as well as the sensory evaluation of the sausages. On the basis of the obtained results, a significant influence of the type of fat raw material on the fat content in the analyzed meat product and its energy value was found. Significant differences were also noted between the treatments of sausages in the values of the color parameters: L, a* and b*, as well as in the texture parameters such as: shear force, cohesiveness, springiness, hardness and chewiness. Homogenized sausage containing goose fat was characterized by high sensory desirability, while the product with the addition of beef tallow was not approved by the sensory panel.*

Słowa kluczowe: tłuszcz wieprzowy grzbietowy, tłuszcz wołowy, tłuszcz gęsi, kiełbasa homogenizowana, cechy jakościowe.

Celem badań było podjęcie próby zastosowania zróżnicowanego surowca tłuszczowego w produkcji kiełbas homogenizowanych oraz ocena jego wpływu na wyróżniki jakości kiełbas. Materiał do badań stanowiły kiełbasy parzone homogenizowane wyprodukowane z udziałem podgardla wieprzowego, słoniny grzbietowej, łoju wołowego oraz tłuszczu gęsiego. W części analitycznej dokonano analizy składu chemicznego, pomiaru parametrów barwy i tekstury oraz przeprowadzono ocenę sensoryczną kiełbas. Na podstawie uzyskanych wyników stwierdzono istotny wpływ rodzaju surowca tłuszczowego na zawartość tłuszczu oraz wartość energetyczną kiełbas. Zauważono również istotne różnice w wartościach parametrów barwy L, a* i b*, a także w wyróżnikach tekstury takich jak: siła cięcia, spoistość, sprężystość, twardość i żujność. Wykazano, że produkt z tłuszczem gęsim odznaczał się wysoką pożądalnością sensoryczną, natomiast produkt z dodatkiem łoju wołowego nie uzyskał aprobaty oceniających.*

INTRODUCTION

Fat in food is, among others a carrier of flavor substances, participating in shaping the palatability of food products and is a protective factor for some food ingredients. It is also an important ingredient that influences the nutritional and health value of food products. It provides fat-soluble vitamins (A, D, E and K), participates in the synthesis of corticosteroids and vitamin D3, and is a valuable energy reserve for the human body [4, 26, 29]. Many consumers associate the term 'fat' primarily with the negatively perceived 'cholesterol', which, if consumed in excess, has a negative impact on human health [2, 3, 11, 18, 28, 30].

Fat raw materials also play a key role in meat processing. Fat – as a recipe ingredient of meat product – is involved in shaping its sensory characteristics, such as: palatability,

Adres do korespondencji - Corresponding author: Krzysztof Dasiewicz, Szkoła Główna Gospodarstwa Wiejskiego w Warszawie, Instytut Nauk o Żywności, Katedra Technologii i Oceny Żywności, Zakład Technologii Mięsa. ul. Nowoursynowska 159C, 02-776 Warszawa, e-mail: krzysztof_dasiewicz@sggw.edu.pl

juiciness, texture and color. These features often determine the choice and purchase of meat products by consumers. Therefore, in relation to many meat products, the presence of fat makes them better perceived from the point of view of consumer preference [5, 8, 21]. Among other things, the texture of meat products made of highly comminuted raw materials depends on the formation of a stable matrix. The formation of this matrix is associated with many factors, including the type, amount and functional properties of proteins (including the content of connective tissue proteins) present in the meat batter system, the type and amount of fat, water and salt content, pH value of the raw meat, etc. Not only the quantity but also the quality of the fat raw material has a significant impact on the quality of the fat-containing meat product. The fat tissue used as a raw material in processed meat products should be white in color and firm in consistency. From the point of view of the health quality and shelf life of the product, the stability of the fat raw material against oxidation processes is important [20]. It has been shown that with the increase in the share of the so-called 'hard fat' in the raw material composition of the meat batter, the values of rheological parameters that characterize the viscoelastic properties of the system are higher [9]. On the other hand, a significant reduction in the fat tissue content in the recipe composition of a meat product causes that the product becomes ‘empty’ in taste, its texture becomes more ‘stiff, ‘gummy’ or ‘mealy’. When selecting the fat raw material in the production of meat products, attention should be also paid to the degree of its freshness and consistency. Too 'soft' fat during the grinding process may 'melt' and also contribute to the formation of an increased loss during technological processes, e.g. thermal treatment and maturation. The selection of fatty raw materials for the recipes of specific groups of meat products is important for meeting the technological assumptions and obtaining the desired quality effects in relation to the product itself, as well as for economic reasons. Some meat products, e.g. dry sausages, require the use of a specific type of fat - pork back fat. The pork back fat is usually used for salami, and fine fat is suitable for the production of pâtés [7, 15, 16].

Literature data on the suitability of the fat raw material obtained from various species of animals for the production of homogenized scalded sausage are scarce. The lack of such information makes it difficult to rationally use fat in meat processing and to obtain the desired product quality in terms of technology, sensory and nutrition. **Therefore, the aim of this study was an attempt to use various fat raw materials (pork, beef and goose fat) in the production of homogenized scalded sausages, as well as to assess the usefulness of the fat raw materials for the production of this type of sausage based on the evaluation of the technological quality and sensory characteristics of sausages in comparison to a homogenized sausage containing pork jowl in recipe composition.**

MATERIALS AND METHODS

Research material

The pork, beef and goose fat raw material used in the production of homogenized scalded sausages was purchased once in an amount sufficient to perform the experiment. Each fat raw material was standardized by chopping into 2 cm x 2 cm pieces and thorough mixing. Then, the fat raw materials were divided into portions corresponding to subsequent production

Table 1. Recipe composition of homogenized scalded sausages
Tabela 1. Skład surowcowy kiełbas parzonych homogenizowanych

Ingredients [%] Składniki [%]	Treatments of homogenized scalded sausages Warianty kiełbas homogenizowanych			
	treatment I (Control) wariant I (kontrolny)	treatment II wariant II	treatment III wariant III	treatment IV wariant IV
Fat raw material / Surowiec tłuszczowy	pork jowl podgardle wieprzowe	pork back fat słonina	beef tallow łój wołowy	goos fat tłuszcz gęsi
Pork trimmings (class I) / Mięso wieprzowe kl. I	60,0	60,0	60,0	60,0
Fat / Tłuszcz	30,0	30,0	30,0	30,0
Pork skin emulsion / Emulsja ze skór wieprzowych	10,0	10,0	10,0	10,0
Ice / Lód	30,0*	30,0*	30,0*	30,0*
Curing salt / Peklosól	1,8*	1,8*	1,8*	1,8*
Soy protein preparation / Preparat białka sojowego	1,5*	1,5*	1,5*	1,5*
Phosphates / Fosforany	0,15*	0,15*	0,15*	0,15*
Sodium ascorbate / Askorbinian sodu	0,05*	0,05*	0,05*	0,05*
Spice mix / Mieszanka przypraw	1,0*	1,0*	1,0*	1,0*

* in relation to meat and fat raw materials / *w stosunku do surowca mięsnego i tłuszczowego

Source: The own study
Źródło: Badanie własne

series, vacuum-packed and stored in a freezer (temperature -18°C) for no longer than 4 weeks. The functional additives included in the recipe were purchased from a one of leading distributors of functional substances in the meat industry.

The material for the research was homogenized scalded sausages, which were produced according to the recipe composition showed in Table 1 and to the production scheme compliant with good production practice (Figure 1).

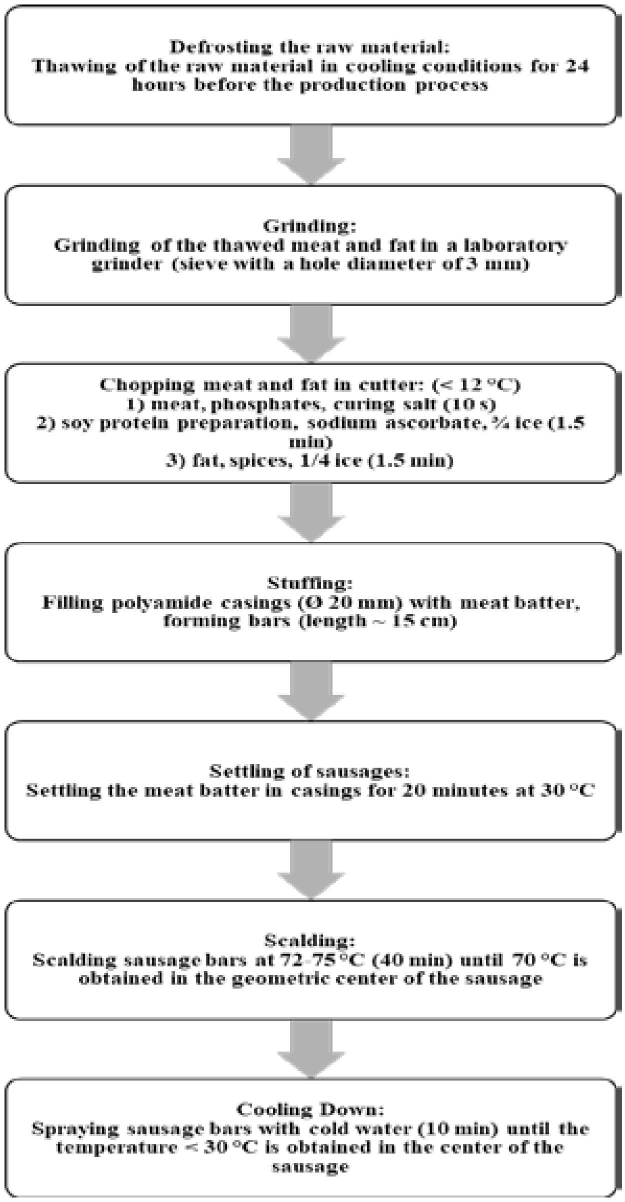

Fig. 1. Production scheme of homogenized scalded sausages.
Rys. 1. Schemat produkcji kiełbas parzonych homogenizowanych.
Source: The own study
Źródło: Badanie własne

Assessment of the chemical and physical quality characteristics of sausages

The production yield of each sausage treatment was calculated from the difference in weight of the sausage bars before and after the heat treatment. The content of basic chemical components in both fat raw materials and sausages was determined by use of a FoodScanÔ Lab apparatus (Foss Analytical A/S, Hillerød, Denmark) using the method of near-infrared reflectance (NIR) transmission spectrophotometry, working in the wavelength range 850-1050 nm. Measurements were made in accordance with the PN-A-82109: 2010 [26] standard and the operating manual of the apparatus. The color sausages was measured using the colorimetric method in accordance with PN-N-01252:1965 [25]. A Konica Minolta CR-200 colorimeter (light source: D65, observer angle: 2°, measuring head hole diameter: 8 mm) was used. Color parameters were measured in the CIEL*a*b* scale. The color of the products was measured on the surface and cross-section of sausage bars after 24 hours as well as after 14 days of storage of vacuum packed (vacuum: 50 mBa) sausages in cold room (4°C). Based on the value of the L*, a* and b* color parameters, ΔE was calculated, i.e. the absolute color difference between the control treatment of sausage (treatment I) and the experimental treatments of sausages (treatments II-IV) . The absolute color difference was calculated using the formula [23]:

$$\Delta E = \sqrt{(L_1^* - L_2^*)^2 + (a_1^* - a_2^*)^2 + (b_1^* - b_2^*)^2}$$

where: L*1, a*1, b*1 – are the color parameters of the control treatment of sausage,
L*2, a*2, b*2 – are the color parameters of the experimental treatment of sausage.

The texture of the sausages was measured using a Zwicki 1120 testing machine (Zwick GmbH & Co, Ulm, Germany) by performing a Texture Profile Analysis (TPA) test (double compression test). Texture measurements were carried out in sausages after 24 hours of storage (4°C), as well as after 14 days of storage (4°C) of vacuum-packaged (vacuum: 50 mBa). The measurements according to the instructions of the measuring apparatus [17]. Before the measurements, the sausage samples (20 mm 'tall' pieces of bar, without casing) were conditioned at the ambient temperature of about 20°C for 1 hour. To perform the TPA test, a cylindrical sausage sample was placed between two parallel plates and compressed to 50% of the original height in each test cycle. The working parameters of the testing machine were as follows: distance between the plates 40 mm, initial force 0.5 N, speed of the measuring head during the test 30 mm/min. The course and the measurement result were recorded using the testXpert computer program. Six measurements were made for each sausage treatment in each experimental series. The mean value of all measurements was taken as the final result [10, 17]. Ten panellists of both sexes participated in the sensory evaluation of sausages. All panellists were familiar with the principles of sensory evaluation of food products. The scaling method was used for the sensory evaluation of sausages. Sausages were evaluated warm, i.e. heated to 50 °C. Each sausage was cut into slices, which were randomly distributed in white plates, and identified with a random two-digit number. The sausage samples were evaluated for taste, smell, color, texture, feel of 'greasiness' and overall desirability. Each quality attribute of sausages was assessed using a scale from 1 to 5 points, corresponding to 'least acceptable' and 'most acceptable', respectively [1].

Statistical analysis of the results

Data were statistically analyzed using the Statistica™ v.12 software (StatSoft Inc., Tulsa, OK, USA). One-way analysis of variance (ANOVA) was performed to determine the significance of differences between the mean values. Tukey's HSD test was used to identify significant differences between the mean values at a level of $\alpha = 0.05$. Before applying ANOVA the Shapiro-Wilk test was used to evaluate the experimental data for normality and the Levene test was used to determine the homogeneity of variances for sets of analytical data [12, 14].

RESULTS AND DISCUSSION

The technological usefulness of animal fat raw materials is determined primarily by their physicochemical properties. The fat content in the tested raw materials, determined by the method of NIR spectrophotometry, showed a significant ($p < 0.05$) differentiation (Table 2). Goose fatty tissue was characterized by the highest fat content. Slightly lower fat content was found in pork back fat. On the other hand, beef tallow and pork jowl were characterized by the clearly lowest proportion of this chemical component, which could have been caused by the presence of small amounts of muscle tissue naturally occurring in this raw materials. The presence of muscle and connective tissue in the analyzed fat raw materials most likely influenced the percentage of protein in them (Table 2). The highest protein content was found in pork jowl and beef tallow, and the lowest in goose fat. The water content in the fat raw materials used in the production of sausages also varied (Table 2). Water content was significantly ($p < 0.05$) lower in goose fat and pork back fat, while it was higher in beef tallow. Higher water content in fatty tissue contributes to its greater susceptibility to the development of pathogenic microflora and an increased tendency to become rancid. Such fat is characterized by lower melting properties, and therefore its technological usefulness may be limited.

Different collagen content was also found in the analyzed fat raw materials – the highest in those characterized by the higher amount of muscle and connective tissue in the overall structure (pork jowl, beef tallow), and the lowest in the fat raw materials with the highest percentage of fat (pork back fat, goose fat) (Table 2).

The production yield of all treatments of homogenized sausages was determined by the weighing method after the completion of the technological process, which was typical for this type of product (Figure 1). It was not significantly ($p > 0.05$) differentiated by the fat raw material used and was at the level of about 85%. Only insignificantly lower thermal losses in the homogenized sausage with the addition of goose fat (88.6%) and higher in the product with the addition of pork jowl (81.9%) were found.

Physical and chemical quality characteristics of homogenized sausages differing in the type of fat raw material were determined by determining their basic chemical composition (Table 3), measuring color parameters according to the CIEL*a*b* scale (Table 4), instrumental texture measurement (Table 4) and evaluation of sensory quality (Table 6).

Consumers aware of the relationship between the quality of consumed food products and health, more often look for products with increased nutritional value and/or reduced energy value, and pay attention to its functional properties, i.e. a positive effect on human health. Meat and meat products are among the richest sources of protein and important sources of minerals, especially well-absorbed heme iron. With regard to meat products with improved health quality, consumer preferences are focused primarily on: modifying the fatty acid profile, lowering the salt content, increasing the share of fiber in the product [22].

The content of chemical components in meat products depends primarily on their raw material composition and the applied methods of technological processing. This relationship has been confirmed by the results obtained in this study. The differences in the protein and water content between the treatments of homogenized scalded sausages were not significant ($p > 0.05$). Only a slightly higher content of these chemical components in the product with the addition of pork jowl can be indicated (Table 3). However, the differences in the average fat content between treatments of meat products compared to the product with pork jowl (Control) were statistically significant ($p < 0.05$). The Control sausages had the lowest percentage of fat. Products with the addition of beef tallow and pork back fat had a similar fat content. On the other hand, the highest fat content was found in sausages with the

Table 2. The content of basic chemical components in fat raw materials used in the production of sausages
Tabela 2. Zawartość podstawowych składników chemicznych w surowcach tłuszczowych użytych do produkcji kiełbas

	Water [%] / Woda [%]	Fat [%] / Tłuszcz [%]	Protein [%] / Białko [%]	Collagen [%] / Kolagen [%]
Pork jowl **Podgardle wieprzowe**	30,79	58,28	9,91	1,75
Pork back fat **Słonina**	12,00	81,77	6,29	0,15
Beef tallow **Łój wołowy**	28,63	63,78	7,54	2,8
Goose fat **Tłuszcz gęsi**	9,53	90,39	2,41	0,67

Source: The own study
Źródło: Badanie własne

Table 3. The effect of the addition of a various fat raw material on the chemical composition of homogenized scalded sausages

Tabela 3. Wpływ dodatku zróżnicowanego surowca tłuszczowego na skład chemiczny badanych kiełbas homogenizowanych

Chemical component Składnik chemiczny	Sausage treatment/Wariant kiełbasy			
	homogenized sausage with pork jowl / kiełbasa homogenizowana z dodatkiem podgardla (Control)	homogenized sausage with pork back fat / kiełbasa homogenizowana z dodatkiem słoniny (treatment II)	homogenized sausage with beef tallow / kiełbasa homogenizowana z dodatkiem łoju wołowego (treatment III)	homogenized sausage with goose fat / kiełbasa homogenizowana z dodatkiem tłuszczu gęsiego (treatment IV)
Water/Woda [%]	59,10a±2,93	54,55a±3,24	56,00a±4,24	52,3a±3,90
Protein/Białko [%]	16,45a±1,29	15,49a±1,30	15,36a±1,24	14,22a±1,44
Fat/Tłuszcz [%]	21,71a±1,29	27,76bc±2,49	24,06ab±1,56	29,52c±1,44
Sodium chloride/Sól kuchenna [%]	1,80a±0,17	1,85a±0,20	1,76a±0,16	1,73a±0,26
Energy value/Wartość energetyczna [kJ/100 g]	262,79a±23,35	308,25b±26,00	289,23ab±16,43	310,62b±12,84

Means in the row marked with the same letter do not differ statistically significantly ($p > 0.05$).
Wartości średnie w wierszach oznaczone tą samą literą nie różnią się statystycznie istotnie ($p > 0.05$).

Source: The own study
Źródło: Badanie własne

addition of goose fat. The determined average fat content in the sausages constituting the research material in this study reflects its percentage share in the fat raw materials used in the production of individual treatments of the sausages. This means that the higher content of fat in the fat raw material resulted in a higher content of this chemical component in the homogenized scalded sausage. The diversified fat content in sausages differing in the type of fat raw material significantly ($p < 0.05$) influenced their energy value. Sausages made with the addition of pork back fat and goose fat had a significantly ($p < 0.05$) higher energy value. Therefore, they were treatments of sausages, the fat raw material of which contained the most fat in its composition.

The measurement of color parameters is one of the basic determinations used in the assessment of the quality of food products. Color is also one of the most important quality determinants of processed meat. Among other things, on the basis of it, the consumer makes a decision about the purchase and consumption of the product, an unusual or changed color is perceived negatively. The results of the instrumental color measurement showed significant ($p < 0.05$) differences in the lightness (L*) of the surface of the sausages. The highest value of lightness parameter measured on the surface was identified for sausages with the addition of goose fat. In the case of the remaining tested sausages, no significant differentiation of this color parameter was found. Significant ($p < 0.05$) differences in the mean value of the color parameter a * (redness) compared to the product with the addition of pork jowl (Control) were observed in sausages with beef tallow and goose fat. These products were characterized by a lower proportion of red color than the other tested sausages. Homogenized sausages with pork back fat had a slightly higher proportion of red color than the control product, but the difference was not significant ($p > 0.05$). The mean values of the b* color parameter (yellowness) measured on the surface of the homogenized sausages did not differ significantly ($p > 0.05$).

After 14 days of chilled storage, homogenized sausages with the addition of beef tallow (treatment III) and goose fat (treatment IV) were characterized by a significantly ($p < 0.05$) lighter color (higher value of the L * parameter) measured on the surface of the sausage bar compared to the product made with pork jowl (Control). In the case of the a* parameter, after 14 days of chilled storage compared to the Control treatment of the homogenized sausage, only the product with the addition of pork back fat (treatment II) was characterized by a significantly ($p < 0.05$) higher proportion of red color. Compared to the Control product (with pork jowl), both the sausage with beef tallow (treatment III) and goose fat (treatment IV) were characterized by a lower value of the a* parameter, but these differences were not statistically significant ($p > 0.05$). However, in the case of the b* parameter, it was shown that sausages with the addition of pork back fat (treatment II) and goose fat (treatment IV) were characterized by a higher yellowness than the product with the addition of pork jowl. The analysis of the color parameters of homogenized sausages, measured on the cross-section of sausage bars 24 hours after production (Table 4) showed that homogenized sausages with the addition of pork back fat and beef tallow (treatments II and III, respectively) were characterized by a significantly ($p < 0.05$) higher value of the color parameter L* compared to a sausage with pork jowl (Control). On the other hand, the use of goose fat in the recipe composition of homogenized sausage resulted in significantly ($p < 0.05$) the highest value of the lightness parameter measured on the sausage cross-section. The product with goose fat (treatment IV) had a significantly ($p < 0.05$) lower value of the a* parameter measured on the cross-section of sausage bars. The value of this parameter in the case of other treatments of sausages was at a similar level. The lowest value of the b * parameter measured on the cross-section of sausage bars was detected for product with beef tallow. After 14 days of refrigerated storage, the observed trends regarding

Table 4. The effect of the addition of a various fat raw material on the color parameters (L*, a*, b*) on the surface and on the cross-section, as well as on the texture parameters of the homogenized scalded sausages stored in cold room for 24 h and 14 days

Tabela 4. Wpływ dodatku zróżnicowanego surowca tłuszczowego na parametry barwy L*, a* i b* na powierzchni i na przekroju oraz parametry tekstury kiełbas homogenizowanych parzonych przechowywanych w warunkach chłodniczych przez 24 h i 14 dni

Characteristic Cecha	**Sausage treatment/Wariant kiełbasy**							
	homogenized sausage with pork jowl kiełbasa homogenizowana z dodatkiem podgardla (Control)		homogenized sausage with pork back fat kiełbasa homogenizowana z dodatkiem słoniny (treatment II)		homogenized sausage with beef tallow kiełbasa homogenizowana z dodatkiem łoju wołowego (treatment III)		homogenized sausage with goose fat kiełbasa homogenizowana z dodatkiem tłuszczu gęsiego (treatment IV)	
	24 h	**14 d**	**24 h**	**14 d**	**24 h**	**14 d**	**24 h**	**14 d**
Color parameters L*, a*, b* measured on the surface of the sausage bar Parametry barwy L*, a*, b* mierzone na powierzchni batonu kiełbasy								
L*	66,86a±2,67	67,04A±1,81	66,60a±2,85	66,38AB±3,19	67,70a±1,66	68,00B±1,27	70,74b±1,15	69,76C±0,99
a*	11,49c±0,97	11,19A±0,89	12,11c±0,10	12,57B±0,97	10,33b±1,42	9,76A±0,68	8,96a±1,08	8,96A±0,75
b*	11,53a±0,98	11,46A±1,05	12,57a±1,39	13,03C±1,55	11,53a±1,58	11,45A±1,22	12,10a±0,67	12,99B±1,06
Color parameters L*, a*, b* measured on the cross-section of the sausage bar Parametry barwy L*, a*, b* mierzone na przekroju batonu kiełbasy								
L*	67,50a±0,52	67,37A±0,75	68,65b±0,46	68,97B±0,34	68,37b±0,76	68,81B±0,74	74,13c±0,52	73,68C±0,44
a*	10,87b±0,59	11,12B±0,53	10,84b±0,57	11,41B±0,48	11,31b±0,59	11,28B±0,46	8,74a±0,69	9,02A±0,63
b*	9,36b±0,37	9,79B±0,36	10,32c±0,60	10,24B±0,45	8,69a±0,99	8,91A±0,88	9,90bc±0,27	10,02B±0,37
Texture parameters of the homogenized scalded sausages Parametry tekstury kiełbas homogenizowanych parzonych								
Shear force [N] Siła cięcia [N]	17,84b±2,28	21,80B±2,76	14,76a±1,94	17,92A±1,48	16,53ab±1,93	16,64A±1,38	15,17a±2,70	16,66A±1,42
Cohesiveness Spoistość	0,67a±0,05	0,72B±0,03	0,62a±0,05	0,66A±0,02	0,63a±0,07	0,66A±0,03	0,63a±0,04	0,69AB±0,06
Springiness Sprężystość	0,81bc±0,004	0,87B±0,02	0,78ab±0,03	0,84A±0,02	0,81c±0,04	0,86AB±0,01	0,77a±0,04	0,85AB±0,05
Hardness [N] Twardość [N]	12,27b±2,20	11,56B±1,48	11,17b±1,1	13,17C±1,46	11,26b±1,98	12,68CB±1,62	8,12a±2,33	9,17A±1,31
Chewiness [N] Żujność [N]	6,54b±0,99	7,29B±0,92	5,45b±0,96	7,34B±0,99	5,78b±1,41	7,71B±1,17	3,99a±1,46	5,41A±1,23

Means in the rows for sausages stored for 24 h and marked with the same lowercase letter do not differ statistically significant ($p > 0.05$).
Wartości średnie w wierszach odnoszące się do kiełbas przechowywanych przez 24 h i oznaczone tą samą małą literą nie różnią się statystycznie istotnie ($p > 0.05$).
Means in the columns for sausages stored for 14 d and marked with the same uppercase letter do not differ statistically significant ($p > 0.05$).
Wartości średnie w wierszach odnoszące się do kiełbas przechowywanych przez 14 d i oznaczone tą samą wielką literą nie różnią się statystycznie istotnie ($p > 0.05$).

Source: The own study

Źródło: Badanie własne

color differences on the cross-section of sausage bars (as after 24 hours from production) were maintained. The inclusion of goose fat in the recipe composition of sausages (treatment IV) had the greatest impact on the lightness of the color measured in the cross-section of the product.

The obtained data show (Table 5) that the absolute color difference ΔE concerning the color of the sausages on the cross-section and the surface of sausage bars between the homogenized scalded sausage manufactured with pork jowl (Control) compared to the sausage with pork back fat (treatment II) and with beef tallow (treatment III) was at a level noticeable only by an experienced observer. The highest absolute color difference on the cross-section and surface of sausages was observed in the case of homogenized sausage with the addition of goose fat (treatment IV). Compared to the Control treatment, the difference in color regarding the sausage surface of treatment IV was at the level noticeable by an inexperienced observer. In the case of the evaluation of the color difference on the cross-section of the sausage bar of treatment IV, the calculated ΔE value – regardless of the

Table 5. The absolute color difference ΔE of sausages in relation to the color evaluated on the cross-section of a homogenized sausage with pork jowl (Control)

Tabela 5. Wartość bezwzględnej różnicy barwy ΔE kiełbas w stosunku do barwy oznaczonej na przekroju kiełbasy homogenizowanej z dodatkiem podgardla (kiełbasa kontrolna)

The value of the absolute color difference ΔE Wartość bezwzględnej różnicy barwy ΔE			
Warunki pomiaru Measurement conditions	homogenized sausage with pork back fat / kiełbasa homogenizowana z dodatkiem słoniny (treatment II)	homogenized sausage with beef tallow / kiełbasa homogenizowana z dodatkiem łoju wołowego (treatment III)	homogenized sausage with goose fat / kiełbasa homogenizowana z dodatkiem tłuszczu gęsiego (treatment IV)
Surface of the sausage bar / Powierzchnia batonu			
24 h of cold storage 24 h przechowywania chłodniczego	1,21*	1,00*	4,07*
14 d of cold storage 14 dni przechowywania chłodniczego	1,74*	1,23*	4,48*
Cross-section of the sausage bar / Przekrój batonu			
24 h of cold storage 24 h przechowywania chłodniczego	1,83*	1,78*	6,75*
14 d of cold storage 14 dni przechowywania chłodniczego	1,67*	1,70*	6,65*

0 < ΔE < 1 – the observer cannot see the color differences

1 < ΔE < 2 – an experienced observer will notice a difference in color

2 < ΔE < 3,5 – an inexperienced observer will notice a difference in color

3,5 < ΔE <5 – there is a noticeable difference in color

5 < ΔE – the observer has the impression of two different colors

* statistically significant differences ($p < 0.05$) / * różnice statystycznie istotne ($p < 0.05$)

Source: The own study

Źródło: Badanie własne

storage time (24 h and 14 days) - indicated that the standard observer should have the impression of two different colors, which proves a significant influence of goose fat on the color of the meat product, which is a homogenized scalded sausage.

Texture is one of the most important features determining the quality and acceptance of products by consumers, as well as a quality factor related to satisfaction when consuming meat products. The International Organization for Standardization (ISO) defines texture as ‘all the rheological and structural properties of a food product that can be perceived by humans through touch, mechanical and, if possible, visual and auditory receptors’ [24]. There are main (independent) and secondary (dependent) texture parameters of food products. The main ones are: hardness, cohesiveness, elasticity (springiness), resilience, and adhesion. The secondary parameters of the texture include, among others chewiness, i.e. the energy needed to crush (chew) the product - this feature is related to hardness, elasticity and cohesiveness. The values of the texture parameters in meat products depend mainly on the characteristic features of the meat and fat raw materials used for their production and the technological processes carried out [13]. In this study, the highest values of shear force, regardless of the sausage storage time (24 hours and 14 days), were recorded for homogenized sausages prepared with the addition of pork jowl (Table 4). Based on the results of the TPA, it was found that the lowest values of the hardness, chewiness and springiness were obtained in homogenized sausage with the addition of goose fat (treatment IV). This tendency was found regardless of the storage time of the sausages (24 h and 14 days) in the cold room.

Among the many criteria that determine the selection and purchase of a food product, its sensory attributes are one of the most important [19]. Introducing new food products to the market is the result of changing market trends as well as the requirements and preferences of consumers. It is the consumer who decides whether the product will find its place on the market. Thus, the consumer plays a fundamental role in each of the stages of product design, both in the area of initiating the process of creating a new product, testing, and implementing it into production and sales on the market [6]. The results of the sensory evaluation of the sausages being the subject of this study are presented in Table 6.

Homogenized scalded sausages produced in this study were of good sensory quality, regardless of the type of fat used in production. The analysis of their sensory attributes showed that the best quality was achieved by homogenized sausage containing goose fat and pork jowl (variant IV and Control, respectively). For these sausage treatments the mean scores for color, aroma, taste and overall desirability were significantly ($p < 0.05$) higher than for those of sausages made with the addition of pork back fat and beef tallow (treatments II and III, respectively). Only the feeling of greasiness was significantly

Table 6. The effect of the addition of a various fat raw material on sensory quality attributes of the homogenized scalded sausages

Tabela 6. Wpływ dodatku zróżnicowanego surowca tłuszczowego na wyróżniki jakości sensorycznej kiełbas homogenizowanych parzonych

Sensory attribute Wyróżnik sensoryczny	Sausage treatment/Wariant kiełbasy			
	homogenized sausage with pork jowl / kiełbasa homogenizowana z dodatkiem podgardla (Control)	homogenized sausage with pork back fat / kiełbasa homogenizowana z dodatkiem słoniny (treatment II)	homogenized sausage with beef tallow / kiełbasa homogenizowana z dodatkiem łoju wołowego (treatment III)	homogenized sausage with goose fat / kiełbasa homogenizowana z dodatkiem tłuszczu gęsiego (treatment IV)
Color / Barwa	4,06b±0,76	3,91ab±0,78	3,63a±0,79	4,16b±0,77
Aroma / Zapach	4,03ab±0,78	4,16b±0,77	3,56a±0,72	4,31b±0,64
Taste / Smak	3,97b±1,18	3,03a±1,42	2,72a±0,85	3,91b±0,93
Texture / Konsystencja	4,16b±0,85	3,84ab±0,77	3,41b±0,61	4,25b±0,80
Feeling of greasiness / Odczucie tłustości	2,53a±0,91	2,87a±0,91	3,06b±0,88	3,09b±0,93
Overall desirability / Ogólna pożądalność	4,18b±0,64	3,34a±0,65	3,03a±0,90	4,03b±0,74

Means in the rows marked with the same letter do not differ statistically significant ($p > 0.05$).
Wartości średnie w wierszach oznaczone tą samą literą nie różnią się statystycznie istotnie ($p > 0.05$).

Source: The own study

Źródło: Badanie własne

($p < 0.05$) higher – which indicates a lower quality of the product – for homogenized sausages with the addition of beef tallow and goose fat (treatments III and IV, respectively).

SUMMARY AND CONCLUSIONS

The aim of the work was an attempt to use various fat raw materials: pork back fat, beef tallow and goose fat, in the production of sausages and to determine their influence on the technological quality and sensory characteristics of sausages in comparison to the control product containing the pork jowl. The experimental material was homogenized scalded sausages, manufactured according to a standard production process. In order to compare the quality of the sausages, the chemical composition analysis was carried out, the color and texture parameters were measured, and the sensory evaluation was performed. Based on the research, it was found that:

1. Although relatively high differences in the content of basic chemical components (water, protein, fat) of fat raw materials, the use of these raw materials for the production of homogenized sausages significantly differentiated only the content of fat and energy value of the products. The fat content and energy value of homogenized sausages produced with the use of fat raw material other than pork jowl was higher, ranging from slightly over 24% to around 30% and from around 290 kJ/100 g to slightly over 310 kJ/100 g, respectively. Regardless of the type of fat material, homogenized sausages were characterized by a relatively high protein content, i.e. not less than 14.22%, and a low salt content, i.e. not more than 1.85%. The obtained results confirm the possibility of modifying the nutritional value of this type of meat products through the selection of fat raw material for production. Taking into account the nutritional value of sausages, and mainly the fat content, it was found that especially products containing goose fat and pork back fat in the recipe composition should not be consumed by people limiting the amount of fat in their diet.
2. The significant differences found in the color parameters of homogenized sausages were also most likely caused by the type of fat used in production. The greatest differences in the color of sausages, both on the surface of the sausage bars and on the cross-section of the sausage bars, were caused by replacing pork jowl with goose fat. A significant increase in the L* color parameter and a significant decrease in a* color parameter – when measured on the cross-section – was found in the sausage with goose fat, both after 24 hours and 14 days of storage in cold room. The calculated values of the ΔE index showed that – regardless of the product storage time – the difference in the color of the surface between the sausage with goose fat and the Control sausage (with pork jowl) should be clearly noticeable by an inexperienced observer, and in the case of the color on the cross-section of both sausage treatments the observer may even get the impression that there are two different colors. The obtained results confirm that in creating the color of a meat product made of highly comminuted raw materials, not only the amount and type of meat, but also the fat raw material should be taken into account. The diversified structure of fat raw materials in terms of the content of muscle and connective tissue may result in a change in the lightness of the product as well as the share of redness and yellowness.
3. Based on the results of the sensory evaluation, it was shown that products with beef tallow in the recipe composition were the least desirable in terms of all attributes, which creates limited prospects for introducing this type of products to the market. The greatest potential

for replacing pork jowl in the production of homogenized scalded sausages would be goose fat. Average scores for the sensory attributes of sausage with goose fat did not differ significantly from those for sausage with pork jowl, except for the feeling of greasiness, which was more ‘pronounced’.

* * *

Summarizing the results of this study, it can be concluded that research on the rational utilization of various fatty raw materials generated in meat production is still necessary, including the possibility of introducing them to the recipe composition of various types of meat products. Such projects should contribute to reducing the amount of waste in the food industry, reducing food waste, and thus improving living conditions.

PODSUMOWANIE I WNIOSKI

Celem przeprowadzonych badań była próba wykorzystania zróżnicowanego surowca tłuszczowego: wieprzowego, wołowego oraz gęsiego w produkcji kiełbas homogenizowanych oraz określenie jego wpływu na cechy jakości technologicznej i sensorycznej w porównaniu do produktu kontrolnego zawierającego w składzie surowcowym podgardle wieprzowe. Materiał doświadczalny stanowiły kiełbasy homogenizowane parzone, wytworzone zgodnie z typowym procesem produkcyjnym dla tej grupy wyrobów mięsnych. W celu porównania jakości kiełbas dokonano analizy ich składu chemicznego, pomiaru parametrów barwy i tekstury oraz przeprowadzono ocenę sensoryczną. Na podstawie badań stwierdzono, co następuje:

1. Pomimo znacznego zróżnicowania zawartości podstawowych składników chemicznych (woda, białko, tłuszcz) w surowcach tłuszczowych, zastosowanie tych surowców do produkcji kiełbas homogenizowanych różnicowało istotnie jedynie zawartość tłuszczu w produkcie oraz ich wartość energetyczną. Zawartość tłuszczu oraz wartość energetyczna kiełbas homogenizowanych wyprodukowanych z udziałem surowca innego niż podgardle wieprzowe była wyższa, kształtując się na poziomie odpowiednio od nieco ponad 24% do około 30% oraz od około 290 kJ/100 g do nieco ponad 310 kJ/100 g. Niezależnie od rodzaju surowca tłuszczowego, kiełbasy homogenizowane cechowały się relatywnie wysoką zawartością białka, tj. nie niższą niż 14,22% oraz niską zawartością soli kuchennej, tj. nie wyższą niż 1,85%. Uzyskane wyniki stanowią potwierdzenie możliwości modyfikacji wartości odżywczej tego typu produktów mięsnych przez dobór surowca tłuszczowego do produkcji. Biorąc pod uwagę wartość odżywczą kiełbas, a głównie zawartość tłuszczu, stwierdzono, że zwłaszcza produkty zawierające tłuszcz gęsi oraz słoninę w składzie recepturowym nie powinny być spożywane przez osoby ograniczające ilość tłuszczu w diecie.
2. Stwierdzone istotne różnice dotyczące parametrów barwy kiełbas homogenizowanych również były najprawdopodobniej spowodowane rodzajem surowca tłuszczowego użytego do produkcji oraz różnicami w barwie tych surowców. Największe różnice w barwie kiełbas, zarówno na powierzchni batonów, jak i na przekroju poprzecznym batonów spowodowane były zastąpieniem podgardla wieprzowego przez tłuszcz gęsi. W kiełbasie z tłuszczem gęsim stwierdzono istotny wzrost parametru barwy L* oraz istotne obniżenie wartości parametru barwy a*, mierzone na przekroju batonu, zarówno po 24 godzinach jak i po 14 dniach przechowywania chłodniczego. Obliczone wartości wskaźnika ΔE wskazywały, że - niezależnie od czasu przechowywania produktu w chłodni - różnica w barwie powierzchni między kiełbasą z tłuszczem gęsim a kiełbasą kontrolną (z podgardlem wieprzowym) była wyraźnie zauważalna przez niedoświadczonego obserwatora, zaś w przypadku barwy na przekroju poprzecznym obu wariantów kiełbas obserwator może nawet odnieść wrażenie występowania dwóch różnych barw. Uzyskane wyniki potwierdzają, że w kreowaniu barwy produktu mięsnego wytworzonego z surowców o dużym stopniu rozdrobnienia należy uwzględnić nie tylko ilość i rodzaj surowca mięsnego, ale także surowca tłuszczowego. Zróżnicowana struktura surowców tłuszczowych w zakresie zawartości tkanki mięśniowej i łącznej może skutkować zmianą jasności produktu oraz udziału w jego barwie czerwieni i barwy żółtej.
3. Na podstawie wyników oceny sensorycznej wykazano, że produkty z łojem wołowym w składzie recepturowym były najmniej pożądane pod względem wszystkich wyróżników, co stwarza ograniczone perspektywy dla wprowadzenia tego typu produktów na rynek. Największe możliwości zastąpienia podgardla wieprzowego w produkcji kiełbas homogenizowanych parzonych miałby tłuszcz gęsi. Noty średnie przyznane w ocenie sensorycznej kiełbasie z tłuszczem gęsim nie różniły się istotnie od tych przyznanych kiełbasie z podgardlem wieprzowym, za wyjątkiem odczucia tłustości, które było bardziej „wyraźne”.

* * *

Podsumowując uzyskane wyniki można stwierdzić, że nadal niezbędne są badania nad racjonalizacją zagospodarowania różnych surowców tłuszczowych generowanych w produkcji mięsa, obejmujących m.in. możliwości wprowadzania ich do składu recepturowego różnorodnych przetworów mięsnych. Działania takie powinny przyczynić się do zmniejszenia ilości odpadów, ograniczenia marnotrawstwa żywności, a tym samym do poprawy warunków życia.

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