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THE IMPACT OF ADDITION OF FRESH AND DRIED ROSEMARY AND ITS EXTRACTS ON THE QUALITY OF MINCED GOOSE MEAT DURING THE COLD STORAGE PERIOD

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Abstract. We investigate the impact of 0.2% addition of fresh and dried rosemary, as well as its extracts obtained during its processing, on the physical, sensory and hygienic quality of minced goose meat during the cold storage period. The analyzes were performed to assess the total number of mesophilic bacteria (including the *Enterobacteriaceae* family and *Staphylococcus* sp.) as well as the psychrophilic aerobic bacteria. We have evaluated pH and color, basing on the designation of L*a*b* parameters of color discriminants and performed the sensory analysis. The addition of fresh and dried rosemary and its extracts during the 7 day cold storage has blocked the activity of mesophilic bacteria in meat, but did not stop the psychrophilic bacteria. The best antibacterial activity was shown by the D rosemary extract. In the groups in which we used the rosemary and its extracts, we have observed the elucidation of meat and a significant increase of b* parameter after 7 days of cold storage. With the increasing time of storage, the decrease in flavor and aroma of minced meat was noted.

Key words: goose, meat, rosemary, quality, microbiology, cold storage

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INTRODUCTION

The quality of meat has a crucial influence on its processing and time of storage of the final meat product. The consumers more likely choose the products that can be stored for a longer period of time, but also pay attention to choose the products that contain no artificial preservatives. To their safety, it is aimed to elongate the period of shelf life of the product and to ensure the proper microbiological quality of meat itself as well as meat products [Turyk et al. 2013]. Herbs are classified as the natural compounds that elongate the storability of meat.

The use of them is an interesting alternative for the artificial preservatives, while they show not only the antibacterial and antifungal activity, but also are characterized by an antioxidative character [Szczepanik 2007].

The most active antimicrobial and antioxidative oil substrates are thymol, eugenol and carvacrol, which are included in the essential oils of rosemary, commonly used as a meat spice [Karpińska-Tymoszczyk 2008]. Due to the very intensive aroma of rosemary, as a food additive it has to be used in a very little amounts. Therefore its antibacterial and antioxidative activity may not be sufficient. For this reason, the production of rosemary extracts, that contain antibacterial and antioxidative substances but are free of an intensive aroma has been undertaken to a wide scale [Karpińska-Tymoszczyk 2013].

The aim of this study was to evaluate the impact of spices (fresh and dried rosemary) and its extracts on the quality of minced goose meat during the cold storage period.

MATERIAL AND METHODS

The research material included the pectoral muscles obtained from 20 carcasses of kołudzka white goose from the poultry farm in Pomorze. The birds have been slaughtered in the poultry farm, eviscerated and frozen. The frozen carcasses were transported in a refrigerated truck to the Laboratory of Food Commodity Sciences, where the main analyzes were performed.

The carcasses were thawing for 24 hours in +4°C. Then the samples for microbiological tests were collected in the sterile conditions. The total number of mesophilic bacteria (including the *Enterobacteriaceae* family and *Staphylococcus* sp.) and psychrophilic aerobic bacteria was evaluated.

In the next step, the pectoral muscles were separated from the carcasses and minced using the mincer with 4 mm strainer. The material has been divided into 7 groups, 1600 g each. The first group was defined as the control group with no herbal additives; in the other groups we added rosemary and its extracts. In the samples, the 0.2% addition of mixed fresh rosemary leaves and dried rosemary by

Kawon was introduced. Also we added the 0.2% of rosemary leave oil extract by Kancor, as well as the Herbor P31, H42 and H025 rosemary extracts by AR-POL to 1000 g of a final product. Table 1 is a lists of the additives and natural extracts of rosemary added to meat during the experiment.

Table. 1 The natural additives of *Rosmarinus officianalis* used in goose meat (addition 0.2% for 1000 g of the product)

Tabela 1. Dodatki naturalne z *Rosmarinus officianalis* do mięsa gęsiego (zastosowanie 0,2% na 1000 g produktu)

Code of the additive Kod preparatu	The name of used extract and material Nazwa zastosowanego ekstraktu i surowca	Description of the product Opis produktu
A	Kancor	Oleoresin – extract from the leaves of dried rosemary Oleożywica – ekstrakt z liści suszonego rozmarynu
B	Herbor P31	Powder with 100% of natural rosemary extract Proszek zawierający 100% naturalnego ekstraktu z rozmarynu
C	Herbor H42	Powder with spice extract from the natural rosemary Proszek zawierający ekstrakt przyprawowy z naturalnego rozmarynu
D	Herbor 025	Vegetable oil with natural extract of rosemary Olej roślinny z naturalnym ekstraktem z rozmarynu
E	Dried rosemary leaves	Ground leaves – powder Zmielone liście w formie proszku
F	Fresh rosemary leaves	Chopped leaves Zmiksowane liście

The minced meat was mixed with the recipe compounds using the multifunctional Thermomix by Vorwek tool for 30 seconds, with knife rotation speed at 400 rpm. After the addition of fresh and dried rosemary and the extracts, from each of the groups eight 200 g samples of minced meat were separated (100 g for sensory and 100 g for physical analysis) and put into sterile, polypropylene containers (120 ml) in a cold storage in 4°C. The samples were investigated after 24 h (excluding the microbiological analyzes) and 7 days of storage. The following analyzes were performed in the samples:

Microbiological examination. This analysis was carried according to the norms [PN-A-82055-2:1994, PN-A-82055-3:1994]. The total number on mesophilic bacteria (including the *Enterobacteriaceae* family and *Staphylococcus* sp.) and psychrophilic aerobic bacteria was analyzed [PN-ISO 4832-1998, PN-EN ISO 6888-1- 2001, PN-ISO 17410- 2004];

Meat color. Meat color characteristics were measured using a Mini Scan XE Plus 45/0 by HunterLab unit, with the CIELAB scale (CIE1976). The: L* – lightness, a* – redness, b* – yellowness parameters were defined.

Standarization. The unit was standardized according to the black standard and white standard with the following coordinates: X = 78.5, Y = 83.3 and Z = 87.8 (for the D65 illuminate and the standard observer – 100);

pH. The value of pH was measured in the water extract (distilled water) and 1 hour of extraction in 1:1 meat : water ratio, using the glass ESAgP-306W electrode and a CyberScan 10 pH-meter (EUTECH CYBERNETICS PTE LTD);

Sensory analysis. Minced meat was formed into loafs and cooked until the internal temperature reached 82°C, according to Baryłko-Pikielna et al. [1964] in twice the amount of water in relation to the weight of the meat. The flavor and aroma of meat were evaluated by the team of five, tested for their sensory sensitivity, according to PN-ISO-4121 [1998];

Statistical analysis. This was performed using the Statistica 10. Mean values ($\bar{x}$) and standard deviations were calculated. One-way orthogonal ANOVA was used and the differences between groups were assessed with Duncan's test.

DESCRIPTION OF RESULTS

The microbiological quality of minced meat product should meet the recommendations of PN-98/A-82009/A1. According to this norm, the total number of aerobic mesophilic microbes cannot exceed $5.0 \cdot 10^6$ cfu $\cdot$ g^{-1}. In this study, the initial microbial contamination after the meat thawing was $1.6 \cdot 10^6$ cfu $\cdot$ g^{-1} in psychrophilic bacteria and $2.2 \cdot 10^6$ cfu $\cdot$ g^{-1} in mesophilic bacteria (Table 2). According to the mentioned constraints, the hygienic state of meat was consistent with the norm. In the initial analysis and after 7 days of storage, no presence of *Enterobacteriaceae* family and *Staphylococcus* sp. was found (Table 2).

After 7 days of storage in +4°C, the lowest amount of psychrophilic bacteria was found in the sample with fresh rosemary ($6.0 \cdot 10^6$ cfu $\cdot$ g^{-1}), and of mesophilic bacteria in the sample with D rosemary extract ($8.0 \cdot 10^5$ cfu $\cdot$ g^{-1}) (Table 2). Significantly the highest amount of psychrophilic and mesophilic bacteria was found in the control group ($6.0 \cdot 10^7$ cfu $\cdot$ g^{-1} and $2.0 \cdot 10^7$ cfu $\cdot$ g^{-1} respectively). In the study, after 7 days of storage, only the sample with D rosemary extract presented a decrease in the number of mesophilic bacteria ($8.0 \cdot 10^5$ cfu $\cdot$ g^{-1}) in reference to the initial sample. In other samples with rosemary and its extracts, an inhibition of microbial growth was observed, however the best results were reached with C extract ($3.0 \cdot 10^6$ cfu $\cdot$ g^{-1}), dried rosemary (E) ($4.0 \cdot 10^6$ cfu $\cdot$ g^{-1}) and A rosemary extract ($4.4 \cdot 10^6$ cfu $\cdot$ g^{-1}) (Table 2).

The psychrophilic bacteria grew in all groups and the specimens we used did not stop their proliferation. Significantly the lowest amount of those was found in the sample with A rosemary extract, $2.4 \cdot 10^7$ cfu $\cdot$ g^{-1}, whereas Karpińska-Tymoszczyk [2006] found a growth inhibition of mesophilic, psychrophilic and

Table 2. The presence of psychrophilic and mesophilic bacteria in the goose meat in the initial studies and on the 7th day of cold storage (mean ±SD)

Tabela 2. Obecność drobnoustrojów psychrofilnych i mezofilnych w mięsie gęsim w badaniach wyjściowych i siódmym dniu przechowywania w warunkach chłodniczych (średnia ±SD)

Group Grupa	Used rosemary extract Zastosowany preparat rozmarynu	Initial studies Badania wyjściowe	7 days in cold storage 7 dzień przechowywania	
		psychrophilic bacteria bakterie psychrofilne	psychrophilic bacteria bakterie psychrofilne	significance of differences at $p \leq 0.05$ istotność różnic przy $p \leq 0,05$
1.	Control group Grupa kontrolna	$1.6 \cdot 10^6 \pm 1.1 \cdot 10^4$ *	$6.0 \cdot 10^7 \pm 8.6 \cdot 10^5$	1 > 2; 3; 4; 5; 6; 7
2.	Rosemary extract A Ekstrakt rozmarynu A		$2.4 \cdot 10^7 \pm 2.0 \cdot 10^5$	7 < 1; 2; 3; 4; 5; 6
3.	Rosemary extract B Ekstrakt rozmarynu B		$3.2 \cdot 10^7 \pm 2.0 \cdot 10^5$	5 < 1; 2 5 > 6; 7
4.	Rosemary extract C Ekstrakt rozmarynu C		$4.6 \cdot 10^7 \pm 2.0 \cdot 10^5$	4 < 1; 2 4 > 3; 5; 6; 7
5.	Rosemary extract D Ekstrakt rozmarynu D		$3.0 \cdot 10^7 \pm 2.1 \cdot 10^5$	6 < 1; 2; 4 6 >7
6.	Dried rosemary E Suszony rozmaryn E		$3.4 \cdot 10^7 \pm 2.0 \cdot 10^5$	3 < 1; 2 3 > 4; 7
7.	Fresh rosemary F Świeży rozmaryn F		$6.0 \cdot 10^6 \pm 5.0 \cdot 10^4$	2< 1; 3; 4; 5; 6; 7
Group Grupa	Used rosemary extract Zastosowany preparat	mesophilic bacteria bakterie mezofilne	mesophilic bacteria bakterie mezofilne	significance of differences istotność różnic
1.	Control group Grupa kontrolna	$2.2 \cdot 10^6 \pm 2.0 \cdot 10^5$*	$2.0 \cdot 10^7 \pm 2.0 \cdot 10^6$	1 > 2; 3; 4; 5; 6;7
2.	Rosemary extract A Ekstrakt rozmarynu A		$4.4 \cdot 10^6 \pm 1.7 \cdot 10^5$	7 < 1 7 > 6
3.	Rosemary extract B Ekstrakt rozmarynu B		$4.7 \cdot 10^6 \pm 2.6 \cdot 10^5$	5 < 1 5 > 4; 6
4.	Rosemary extract C Ekstrakt rozmarynu C		$3.0 \cdot 10^6 \pm 1.0 \cdot 10^6$	4 < 1; 2; 6 4 > 6
5.	Rosemary extract D Ekstrakt rozmarynu D		$8.0 \cdot 10^5 \pm 8.6 \cdot 10^4$	6 < 1; 2; 3; 4; 5; 7
6.	Dried rosemary E Suszony rozmaryn E		$4.0 \cdot 10^6 \pm 5.0 \cdot 10^5$	3 < 1 3 > 6
7.	Fresh rosemary F Świeży rozmaryn F		$5.3 \cdot 10^6 \pm 1.7 \cdot 10^5$	2 > 1; 3; 4; 5; 6; 7

*Significant differences at $P \leq 0.05$ between the periods of storage.
*Różnice istotne przy $P \leq 0,05$ pomiędzy okresami przechowywania.

coli group bacteria during the cold storage using sage additives in turkey meat half-products. This author has also observed the growth inhibition of psychrotrophic and coli group bacteria as well as *Clostridium* spp. after the use of dried rosemary in turkey meat products [Karpińska-Tymoszczyk 2008]. In the studies

of Juhee et al. [2007] the rosemary oil (Herbalox) has stopped the growth of E. coli in meat.

The pH of pectoral muscles after 24 h storage ranged from 5.8 to 6.02 (Table 3). After 7 days of storage the acidity of meat in the control group was the lowest and reached 5.85. Similar low pH was measured in meat with B rosemary extract, 5.86. In samples with fresh (F) and dried (E) rosemary, the pH was 5.92 and 5.91 respectively; not much lower pH was found in the sample with D rosemary extract. Higher pH (5.94) was observed in the sample with A rosemary extract (Table 3). The acidity of meat at the same level was measured in the group with dried rosemary and B rosemary extract (Table 3). A significant decrease of pH in selected groups during the storage could have been caused by free fatty acids formation in the hydrolysis process or by the growth of lactic acid bacteria. A decrease of pH after 1 and 2 weeks of cold storage was found by Karpińska-Tymoszczyk [2008] by adding the powdered rosemary to turkey meat. Also Macura et al. [2011] have demonstrated the decrease in pH in veal during the cold storage after using the coriander and lemon balm essential oils.

Table 3. The acidity of goose meat after 24 h and 7 days of cold storage (mean ±SD)

Tabela 3. Kwasowość mięsa gęsiego po 24 h i siedmiu dniach przechowywania chłodniczego (średnia ±SD)

Group Grupa	Used rosemary extract Zastosowany preparat rozmarynu	24 hours in storage 24 h przechowywania		7 days in storage 7 dzień przechowywania	
		significant differences at $P \leq 0.05$ istotność różnic przy $P \leq 0,05$	$pH_{24\,h}$	pH after 7 days pH po 7 dniach	significant differences at $P \leq 0.05$ istotność różnic przy $P \leq 0,05$
1.	Control group Grupa kontrolna	1 < 2 1 > 3; 4; 5	5.99 ±0.01*	5.85 ±0.01	1 < 2; 3; 4; 6; 7
2.	Rosemary extract A Ekstrakt rozmarynu A	7 < 2 7 > 3; 5	5.96 ±0.01*	5.94 ±0.02	7 > 1; 3; 5; 6
3.	Rosemary extract B Ekstrakt rozmarynu B	5 < 1; 2; 3; 4; 5; 6; 7	5.86 ±0.01	5.86 ±0.01	5 < 2; 3; 4; 6; 7
4.	Rosemary extract C Ekstrakt rozmarynu C	4 < 1; 2; 7 4 > 5	5.96 ±0.01	5.93 ±0.02	4 > 1; 5 3 < 7
5.	Rosemary extract D Ekstrakt rozmarynu D	6 < 2 6 > 3; 5	5.97 ±0.02*	5.91 ±0.01	6 < 7 6 > 1; 5
6.	Dried rosemary E Suszony rozmaryn E	3 < 1; 2; 4; 6; 7 3 > 5	5.91 ±0.01	5.91 ±0.02	3 > 1; 5 3 < 7
7.	Fresh rosemary F Świeży rozmaryn F	2 > 1; 3; 4; 5; 6; 7	6.02 ±0.02*	5.92 ±0.02	2 > 1; 5 2 < 7

*Significant differences at $P \leq 0.05$ between the periods of storage.
*Różnice istotne przy $P \leq 0,05$ pomiędzy okresami przechowywania.

The demonstrated values of pH after 7 days (from 5.85 to 5.94) indicate the good hygienic and processing quality of meat. According to Stangierski [1993],

an increase of pH in poultry meat above 6.4 may indicate the already initiated process of meat spoilage and Florek [2011] claims that pH higher than 6.8 means the process of meat deterioration.

Pectoral muscles of goose, after 24 h of storage were characterized by the lightness (L*) between 37.14 to 40.31 (Table 4) In the control group, the lightness was 38.71 and was similar to the results obtained by Okruszek et al. [2008], where the mean L* value for pectoral muscle of goose was 38.62. In the other groups, after 1 day of storage, a significant ($P \leq 0.05$) brightening of meat color was observed in comparison to the control group (Table 4). An inverse relation was noted by Semeriak and Jarmoluk [2011], where the addition of rosemary extracts to meat products caused blackening of meat. A significantly darker color of meat was noted only in the group with dried rosemary (Table 4).

Table 4. The lightness of color (L*) of goose meat after 24 h and 7 days of cold storage (mean ±SD)

Tabela 4. Jasność barwy L* mięsa gęsiego po 24 h i siódmym dniu przechowywania w warunkach chłodniczych (średnia ±SD)

Group Grupa	Used rosemary extract Zastosowany preparat rozmarynu	24 hours in storage 24 h przechowywania		7 days in storage 7 dzień przechowywania	
		significant differences at $P \leq 0.05$ istotność różnic przy $P \leq 0,05$	L*	L*	significant differences at $P \leq 0.05$ istotność różnic przy $P \leq 0,05$
1.	Control group Grupa kontrolna	1 < 2; 3; 4; 5; 6; 7	38.71 ±0.02[a]	37.90 ±0.04	1 < 2; 3; 4; 5; 6; 7
2.	Rosemary extract A Ekstrakt rozmarynu A	7 > 1; 3; 4	40.15 ±0.02	40.06 ±0.05	7 < 2; 3; 4; 5; 6 7 > 1
3.	Rosemary extract B Ekstrakt rozmarynu B	5 < 2; 4; 6; 7 5 > 1; 3	39.00 ±0.15[a]	44.81 ±0.07	5 > 1; 2; 3; 4; 6; 7
4.	Rosemary extract C Ekstrakt rozmarynu C	4 > 1; 3; 5	40.12 ±0.01[a]	42.50 ±0.08	4 < 5; 6 4 > 1; 2; 3; 7
5.	Rosemary extract D Ekstrakt rozmarynu D	6 > 1; 2; 3; 5	40.31 ±0.15[a]	44.21 ±0.49	6 < 5 6 > 1; 2; 3; 4; 7
6.	Dried rosemary E Suszony rozmaryn E	3 < 1; 2; 4; 5; 6; 7	37.14 ±0.02[a]	42.01 ±0.04	3 < 4; 5; 6 3 >1; 2; 7
7.	Fresh rosemary F Świeży rozmaryn F	2 < 6 2 > 1; 3; 5	39.91 ±0.04[a]	43.74 ±0.05	2 < 5; 6 2 < 1; 3; 4; 7

[a]Significant differences at $P \leq 0.05$ between the periods of storage.
[a]Różnice istotne przy $P \leq 0,05$ pomiędzy okresami przechowywania.

The seven day period of storage had an important impact of the color of meat (L*). A significant ($P \leq 0.05$) blackening of meat was noted only in the control group (37.90), while the brightening was observed in all other groups except the one with A rosemary extract addition, which was characterized by a stable color (Table 4). The brightening of meat may be related to the proteolytic changes during its storage, which could have caused higher exudation and elucidation of

meat. Blackening of turkey meat after the addition of dried rosemary was found by Karpińska-Tymoszczyk [2012]. Also Turyk et al. [2013] found the darker color of pork meat in the samples with herbal additives. Djenane et al. [2002] have proven the stabilizing effect of rosemary on the color of meat after 29 days of storage. Similar conclusions were made by Sánchez-Escalante et al. [2001], Lund and Skibsted [2007] and Sebranek et al. [2005].

The meat samples with dried rosemary (E) and C rosemary extract were characterized by a significantly higher share of red color (a*) after 24 h of storage in comparison to the other groups (16.26 and 15.72 respectively) (Table 5). The period of storage had an effect on this parameter in all groups. An increase of redness after 7 days of storage was observed in the control group (1.87 unit) and in the group with B rosemary extract (1.52 unit). In the other groups a decrease in red color in meat was noted (Table 5). On the other hand, Semeriak and Jarmoluk [2011] said, that the use of rosemary extract in the process of experimental products manufacturing caused the shift towards the red color.

Table 5. The share of red color (a*) in the goose meat after 24 h and 7 days of cold storage (mean ±SD)

Tabela 5. Udział barwy czerwonej (a*) w mięsie gęsim po 24 h i siódmym dniu przechowywania w warunkach chłodniczych (średnia ±SD)

Group Grupa	Used rosemary extract Zastosowany preparat	24 hours in storage 24 h przechowywania		7 days in storage 7 dzień przechowywania	
		significant differences at $P \leq 0.05$ istotność różnic przy $P \leq 0{,}05$	a*	a*	significant differences at $P \leq 0.05$ istotność różnic przy $P \leq 0{,}05$
1.	Control group Grupa kontrolna	1 < 3; 4; 5; 6; 7 1 > 2	14.26 ±0.03[a]	16.13 ±0.05	1 < 5 1 > 2; 3; 4; 6; 7
2.	Rosemary extract A Ekstrakt rozmarynu A	7 < 3; 4 7 > 1; 2; 6	14.66 ±0.10[a]	14.12 ±0.05	7 < 1; 2; 5; 6 7 > 3
3.	Rosemary extract B Ekstrakt rozmarynu B	5 < 3; 4 5 > 1; 2; 6	14.78 ±0.04[a]	16.30 ±0.07	5 > 1; 2; 3; 4; 6; 7
4.	Rosemary extract C Ekstrakt rozmarynu C	4 < 3, 4 > 1; 2; 5; 6; 7	15.72 ±0.04[a]	14.07 ±0.07	4 < 1; 2; 5; 6 4 > 3
5.	Rosemary extract D Ekstrakt rozmarynu D	6 < 3; 4; 5 5 > 1; 2; 7	14.48 ±0.15[a]	14.77 ±0.04	6 < 1; 5 6 > 3; 4; 6; 7
6.	Dried rosemary E Suszony rozmaryn E	3 > 1; 2; 4; 5; 6; 7	16.26 ±0.25[a]	12.87 ±0.09	3 < 1; 2; 4; 5; 6; 7
7.	Fresh rosemary F Świeży rozmaryn F	2 < 1; 3; 4; 5; 6; 7	13.97 ±0.05[a]	14.73 ±0.03	2 < 3; 5 2 > 1; 2; 4; 7

[a]Significant differences at $P \leq 0.05$ between the periods of storage.
[a]Różnice istotne przy $P \leq 0{,}05$ pomiędzy okresami przechowywania.

In all the samples after 7 days of storage an significant increase in b* parameter was observed. (Table 6). The highest share of yellow after 7 days was noted in the group with B (19.06) and D (18.00) rosemary extract. These results are sup-

ported by Semeriak and Jarmoluk [2011], who noted an increase of yellow from 4.49 (not stored samples) to 4.85 in the products cooked with rosemary after one month of storage.

Table 6. The share of yellow color (b*) in the goose meat after 24 h and 7 days of cold storage (mean ±SD)

Tabela 6. Udział barwy żółtej (b*) w mięsie gęsim po 24 h i siódmym dniu przechowywania w warunkach chłodniczych (średnia ±SD)

Group Grupa	Used rosemary extract Zastosowany preparat	24 hours in storage 24 h przechowywania		7 days in storage 7 dzień przechowywania	
		significant differences at $P \leq 0.05$ istotność różnic przy $P \leq 0,05$	b*	b*	sgnificant differences at $P \leq 0.05$ istotność różnic przy $P \leq 0,05$
1.	Control group Grupa kontrolna	1 < 3; 4; 5; 6; 7 1 > 2	14.52 ±0.04[a]	15.18 ±0.03	1 < 2; 3; 4; 5; 6; 7
2.	Rosemary extract A Ekstrakt rozmarynu A	7 < 3; 4 7 > 1; 2; 6	15.07 ±0.04[a]	16.73 ±0.19	7 < 4; 5; 6 7 > 1; 3
3.	Rosemary extract B Ekstrakt rozmarynu B	5 < 3; 4 5 > 1; 2; 6	15.06 ±0.06[a]	19.06 ±0.05	5 > 1; 2; 3; 4; 6; 7
4.	Rosemary extract C Ekstrakt rozmarynu C	4 < 3 4 > 1; 2; 5; 6; 7	15.55 ±0.05[a]	17.17 ±0.07	4 < 5; 6 4 > 1; 2; 3; 7
5.	Rosemary extract D Ekstrakt rozmarynu D	6 < 3; 4; 5; 7 6 > 1; 2	14.78 ±0.10[a]	18.00 ±0.05	6 < 5 6 > 1; 2; 3; 4; 7
6.	Dried rosemary E Suszony rozmaryn E	3 > 1; 2; 4; 5; 6; 7	16.07 ±0.07[a]	16.41 ±0.19	3 < 2 ; 4; 5; 6; 7 3 > 1
7.	Fresh rosemary F Świeży rozmaryn F	2 < 1; 3; 4; 5; 6; 7	14.2 8±0.24[a]	16.78 ±0.08	2 < 4; 5; 6 2 > 1; 3

[a]Significant differences at $P \leq 0.05$ between the periods of storage.
[a]Różnice istotne przy $P \leq 0,05$ pomiędzy okresami przechowywania.

The addition of fresh (F) and dried (E) rosemary and its extracts did not impair the aroma of cooked meat (Table 7). However Karpińska-Tymoszczyk [2008] has reported the impaired sensory features of turkey meat loafs after adding the mixed rosemary. After 24 h of storage the meat was characterized by an attractive aroma, and the notes ranged from 4.66 to 5.0 points. Significantly the best notes were gained by the group with fresh rosemary (F) and the worst by the group with C rosemary extract (4 points).

The best flavor was typical for the meat after 24 h of storage, and the notes ranges from 4.5 to 3 points. The highest notes were gained by the control group and with the addition of rosemary extracts (Table 8). Significantly lower flavor notes were given to the meat with fresh (F) and dried (E) rosemary (Table 8). The evaluators pointed the intensive smell of this herb, while in the aroma no such dependence was found – samples with fresh and dried rosemary gained high notes after 24 h of storage.

Table 7. The sensory evaluation of aroma of cooked goose meat in the first and seventh day of cold storage (mean ±SD)

Tabela 7. Ocena sensoryczna zapachu gotowanego mięsa gęsiego w pierwszym i siódmym dniu przechowywania w warunkach chłodniczych (średnia ±SD)

Group Grupa	Used rosemary extract Zastosowany preparat	24 hours in storage 24 h przechowywania		7 days in storage 7 dzień przechowywania	
		significant differences* istotność różnic*	aroma, pts zapach, pkt	aroma, pts zapach, pkt	significant differences* istotność różnic*
1.	Control – Grupa kontrolna	–	4.66 ±0.57*	3.50 ±0.5	1 < 3; 7
2.	Extract A – Ekstrakt A	–	4.50 ±0.50	4.50 ±0.0	7 > 1; 5; 4
3.	Extract B – Ekstrakt B	–	4.66 ±0.57	2,83 ±0.3	5 < 2; 3; 6; 7
4.	Extract C – Ekstrakt C	4 < 2	4.00 ±1.00	3.00 ±0.2	4 < 2; 3; 6; 7
5.	Extract D – Ekstrakt D	–	4.66 ±0.57	4.00 ±0.0	6 < 5; 6 > 4; 5
6.	Dried E – Suszony E	–	4.66 ±0.57	5.00 ±0.5	3 > 1; 2; 4; 5; 6
7.	Fresh F – Świeży F	2 > 4	5.00 ±0.02	4.00 ±0.5	2 < 3; 7

*Significant differences at $P \leq 0.05$ between the periods of storage.
*Różnice istotne przy $P \leq 0,05$ pomiędzy okresami przechowywania.

Table 8. The sensory evaluation of flavor of cooked goose meat in the first and seventh day of cold storage (mean ±SD)

Tabela 8. Ocena sensoryczna smakowitości gotowanego mięsa gęsiego w pierwszym i siódmym dniu przechowywania w warunkach chłodniczych (średnia ±SD)

Group Grupa	Used rosemary extract Zastosowany preparat	24 hours in storage 24 h przechowywania		7 days in storage 7 dzień przechowywania	
		significant differences* istotność różnic*	flavor, pts smakowitość, pkt	flavor, pts smakowitość, pkt	significant differences* istotność różnic*
1.	Control – Grupa kontrolna	–	4.50 ±0.50	3.00 ±0.00	–
2.	Extract A – Ekstrakt A	–	4.16 ±1.04	3.50 ±0.50	–
3.	Extract B – Ekstrakt B	–	4.00 ±1.00	2.00 ±1.00	–
4.	Extract C – Ekstrakt C	–	3.83 ±0.76	3.00 ±0.50	–
5.	Extract D – Ekstrakt D	–	4.50 ±0.50	3.33 ±0.57	–
6.	Dried E – Suszony E	3 < 1; 2; 4; 5;.6;7	3.00 ±0.00	3.00 ±0.00	–
7.	Fresh F – Świeży F	–	3.66 ±1.15	3.50 ±0.50	–

*Significant differences at $P \leq 0.05$ between the periods of storage.
*Różnice istotne przy $P \leq 0,05$ pomiędzy okresami przechowywania.

Together with the elongation of storage time, the sensory attractiveness of meat was decreasing. After 7 days, the highest notes for aroma were gained by the group with dried rosemary (5 points) and A rosemary extract (4.5 points). A similarly attractive smell was characteristic for the groups with fresh rosemary (4 points) and D rosemary extract (4 points). An impair was noted for the control

group (3.5 points) and with the addition of C rosemary extract (3 points) (Table 7). An unacceptable decrease in smell was observed only in the group with B rosemary extract (2.83 points). Also Kondratowicz et al. [2011] have observed an impair in the desirability of meat smell in association with the time of storage.

After 7 days, the notes for flavor ranged from 2 to 3.5 points. Unacceptable flavor (2 points) was characteristic for the samples with B rosemary extract (Table 8). The other groups gained notes from 3 to 3.5 points. The decrease in flavor notes in cooked goose meat may be an evidence of the initial stage of spoilage in the cold stored meat. However the main reason of meat flavor decline during the storage may by the activity of bacterial enzymes [Kondratowicz et al. 2011].

CONCLUSION

The addition of 0.2% of fresh and dried rosemary and its extracts during the 7 day period of storage has blocked the activity of mesophilic bacteria in meat, but did not stop the development of psychrophilic bacteria. The best antibacterial activity was shown by the D rosemary extract. A significant ($P \leq 0.05$) decrease in the pH of meat was found in the control group and in the groups with fresh rosemary (F) and D rosemary extract after 7 days of storage. In the groups with rosemary and its extracts, the color of meat brightened and a significant increase in b* parameter after 7 days of storage was found. The group with A rosemary extract was exceptional, as it retained the stable color of meat. Together with the time of storage, a decline in flavor and aroma of minced meat was observed in comparison to the first day of meat samples storage. The lowest notes in the sensory evaluation after 7 days of storage were gained by the B rosemary extract; the smell and flavor of minced meat with the addition of it were described as undesirable. The D rosemary extract turned out to be the best after 7 days of meat storage. It reduced the content of mesophilic bacteria in meat and the samples with it were characterized by the desirable smell and flavor after 7 days of storage.

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WPŁYW DODATKU ŚWIEŻEGO I SUSZONEGO ROZMARYNU ORAZ JEGO EKSTRAKTÓW NA JAKOŚĆ MIELONEGO MIĘSA Z GĘSI W CZASIE CHŁODNICZEGO PRZECHOWYWANIA

Streszczenie. W pracy zbadano wpływ świeżego i suszonego rozmarynu oraz uzyskanych z nich ekstraktów w warunkach przemysłowych w ilości 0,2%, na jakość fizyczną, sensoryczną i higieniczną mielonego mięsa gęsiego, w trakcie przechowywania w warunkach chłodniczych. Badania obejmowały określenie: ogólnej liczby bakterii mezofilnych (w tym bakterie rodziny Enterobacteriace i rodzaju *Staphylococcus* sp.), a także bakterii tlenowych psychrofilnych. Oznaczono wartość pH, wykonano ocenę barwy na podstawie oznaczenia parametrów wyróżników barwy L*a*b*, przeprowadzono analizę sensoryczną. Dodatek świeżego i suszonego rozmarynu oraz jego ekstraktów w trakcie 7 dni przechowywania, zahamował w mięsie działalność bakterii mezofilnych, ale nie powstrzymał rozwoju bakterii psychrofilnych. Najlepsze działanie antybakteryjne wykazał ekstrakt rozmarynowy D. W grupach w których stosowano dodatek rozmarynu i jego ekstraktów obserwowano pojaśnienie barwy mięsa oraz istotny wzrost wartości parametru b*, po 7 dniach przechowywania. Wraz z wydłużaniem czasu przechowywania, stwierdzono pogorszenie smakowitości i zapachu mielonego mięsa.

Słowa kluczowe: gęś, mięso, rozmaryn, jakość, mikrobiologia, przechowywanie

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