THE EFFECT OF PACKAGING METHOD ON LIPID OXIDATION OF TRADITIONAL DRY FERMENTED SAUSAGE *(PETROVSKÁ KLOBÁSA)*

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Abstract – In this paper the effect of hot (sausage A) and cold meat deboning (sausage B), and packaging method (vacuum and MAP) on the lipolytic and oxidative changes, and the sensory properties (taste and smell) of traditional dry fermented sausage (*Petrovská klobása*) were examined during processing and storage. Acid number (mg KOH/g lipid), was quantified according SRPS ISO, and the TBARs test was used to determine the content of malondialdehyde (MDA). The values of acid number in the raw mixtures A and B ranged from 3.20 to 4.35 mg KOH/g lipid, and increased significantly ($P < 0.05$) during drying process and storage time. Malondialdehyde content was the lowest in the raw mixture B (0.31 mg / kg), and the highest in unpacked sausage A (1.31 mg / kg) after 30 days of storage (120 days of production). Vacuum and MAP packaging resulted in significant ($P < 0.05$) decrease in the intensity of oxidative changes in both sausages. During storage, sensory evaluation of taste and smell of sausages B were significantly higher ($P < 0.05$) compared to sausages A. These results indicate a decrease in the intensity of oxidative changes during long term storage in a this traditional sausage manufactured from cold meat and packed in vacuum or MAP.

Key Words – traditional sausage, hot deboning, vacuum, MAP, lipid oxidation

I. INTRODUCTION

The Serbian traditional sausages are, in almost all cases, fermented sausages that undergo a long process of drying-ripening before consumption [1]. One of the most representative Serbian fermented sausages is *Petrovská Kolbása*. It is a traditional dry fermented sausage from municipality of Bački Petrovac (Province of Vojvodina, Serbia). Due to its specific and recognizable quality (texture, flavor and taste), this product has been granted PDO (protected designation of origin), under Serbian law [2]. Dry fermented sausages are meat products with high fat content. Fat is responsible for various properties of dry fermented sausages [3]. However, fermented sausages show some negative aspects as a consequence of their high animal fat content. Namely, the changes in fat during processing fermented sausages, such as lipolysis and lipid oxidation, can damage sensory properties of food products, since fat contributes to flavor, texture, and overall sensation of lubricity of the product [4]. The oxidative stability of muscle foods is usually affected by processing conditions. Many researchers have studied the effect of temperature on lipid oxidation in various foods [5, 6]. Retail storage of dry fermented sausages is usually done in aerobic conditions, the product being exposed to oxygen and, in consequence, to a potential oxidation process. Furthermore, besides lipid oxidation, an excessive dehydration can also occur using traditional storage conditions, leading to economic losses because of the weight losses. [7]. Packaging in modified atmospheres (vacuum and gas packaging) is being introduced as a commercial way for the retail selling of dry fermented sausages. Authors such as Valencia et al., [8] and Rubio et al., [9] have studied the effect of the packaging (vacuum and modified atmosphere) on the lipid oxidation of dry fermented sausages. Knowing all negative effects in lipids during drying and storage of fermented sausages, this study was designed with the aim to determine the effect of raw meat temperature and storage conditions (vacuum and MAP) on intensity of lipolytic and oxidative changes as well as sensory characteristics of traditional sausage *(Petrovská klobása)*.

II. MATERIALS AND METHODS

Two sausages were produced (A and B). Sausage A was produced from hot deboned meat (t ≈ 15-20^{0}C), until sausage B was produced from cold meat (t = 5-7^{0}C). Both sausage mixtures were stuffed in natural casings. Sausages A and B dried in traditional room needed 90 days to reach required moisture content (<35%) by Serbian legislation [10]. After that time, both sausages were divided in three subgroups. The first one consisted of unpacked sausages, while the sausages from the second and the third group were packed under vacuum and in MAP (80% N_2 and 20% $C0_2$), respectively. After packaging, sausages were stored in a chamber with a controlled temperature (15°C) and relative humidity (75%) for 6 months. Analyses of lipolytic and oxidative changes were conducted in both sausage mixtures (0 day), at the end of drying process (90th day) and after 30 and 180 days of storage (120th and 270th day of production), while the analysis of taste and smell were examined at the end of drying process (90th day) and after 30 and 180 days of storage. All determinations were made in three samples from each batch in duplicate.

Acid number (mg KOH/g lipid), was quantified according *SRPS ISO* [11]. The TBARs test was used for determination content of malondialdehyde (MDA) [12]. Sensory evaluation of taste and smell was performed by a panel consisting of 6 trained members of different ages. Evaluation was performed according to quantitative descriptive analysis (QDA), using a scale from 0 to 5, with a sensitivity threshold of 0.25 points [13]. Means were compared by t-test and Duncan's multiple range test, using the computer programme STATISTIKA 8.0 [14].

III. RESULTS AND DISCUSSION

Acid number in raw sausage mixtures A and B (Table 1) was 3.20 and 4.35 mg KOH /g lipid, respectively, and increased significantly ($P < 0.05$) during the entire period of storage in both sausages. An exception was registered for sausage packed in vacuum (120th day), where the acid number (6.38 mg KOH / g lipid) decreased significantly ($P < 0.05$) compared to this value in the sausage at the end of the drying process (9.50 mg KOH / g lipid). An increase in the acid number during the storage time is a result of intensive lipolytic changes that are influenced by both endogenous and microorganisms' enzymes [15]. Usage of hot deboned meat (cca 15-20^{0}C) early *post mortem* (about 3 hours after slaughter) for the sausage production probably influenced the more intensive lipolytic changes in A sausages at the start of the smoking process and during drying and storage (120th day), compared to those registered for B sausages (Table 1). However, at the end of the storage period, content of free fatty acids in B group was significantly ($P < 0.05$) higher than the content in A group.

Table 1 Values of acid number (mg KOH/g lipids) in traditional sausage (*Petrovská klobása)*

BATCH		A	B
0 day		3.20±0.01Aa	4.35±0.02Ba
90 day		9.50±0.03Bc	8.11±0.01Ab
120 day	Unpacked	20.75±0.01Bg	10.93±0.02Ae
	Vacuum	6.38±0.02Ab	9.05±0.03Bc
	MAP	13.21±0.01Be	10.40±0.02Ad
270 day	Unpacked	21.65±0.02Ah	30.10±0.05Bh
	Vacuum	13.15±0.04Ad	18.89±0.02Bf
	MAP	15.62±0.03Af	19.59±0.03Bg

^{AB}indicates significant difference within row ($P < 0.05$); $^{a-g}$ indicate significant differences within column ($P < 0.05$)

Difference in the free fatty acids content between A and B group at the end of storage period probably was the consequence of the increased intensity of oxidative changes in free fatty acids in sausages produced from hot deboned meat.

TBARS test results, expressed as MDA content (mg/kg), are shown in Table 2. During the drying process the content of MDA significantly ($P < 0.05$) increased in both groups of sausages. Furthermore, the MDA content in the unpacked B sausage at the end of the storage period was not significantly ($P > 0.05$) different compared to the values of the sausages at the end of drying process and after 30 days of storage. On the other hand, the MDA content in unpacked A sausage after 30 days of storage was 1.31 mg/kg and was significantly higher compared to the

value of unpacked sausages at the end of storage time (0.88 mg/kg). Decrease in MDA after 180 days of storage in A sausages is probably the result of the TBA reaction with sugars, nitrates, amino acids [16]. Furthermore, the MDA at the end of the drying process and during the entire period of storage for unpackaged sausages was significantly ($P < 0.05$) higher in the A sausages in comparison to the B group. At the end of storage period the contents of MDA in B sausages packed in vacuum and MAP was 0.39 and 0.46 mg/kg, respectively, and was significantly ($P < 0.05$) lower than the ones in A sausages packed in vacuum (0.60 mg/kg) and MAP (0.57 mg/kg). If the MDA content, in packaged sausages (A and B), is correlated with the content of free fatty acids, it could be noted that the sausages which had higher content of free fatty acids (over acid number) had lower MDA content. Furthermore, these results indicate that the use of "cold meat" as well as packaging (vacuum or MAP) contribute to a significant reduction ($P < 0.05$) of MDA content in the traditional dry fermented sausage (*Petrovská klobása*) during storage in relation to the value for the unpackaged sausages and sausages produced from hot deboned meat.

Table 2 The TBARs values (mg/kg) in traditional sausage (*Petrovská klobása)*

SAUSAGE		A	B
0 day		0.65±0.01Bc	0.31±0.01Aa
90 day		1.05±0.02Bg	0.89±0.01Af
120 day	Unpacked	1.31±0.01Bh	0.87±0.03Af
	Vacuum	0.72±0.00Bd	0.65±0.00Ad
	MAP	0.76±0.01Ae	0.82±0.01Be
270 day	Unpacked	0.88±0.03f	0.90±0.02f
	Vacuum	0.60±0.01Bb	0.39±0.01Ab
	MAP	0.57±0.02Ba	0.46±0.03Ac

[AB]indicates significant difference within row ($P < 0.05$); [a-h] indicate significant differences within column ($P < 0.05$)

TBARS values obtained in this study are in agreement with literature data obtained by Ansorena and Astiasarán [7], but much lower compared to the results obtained by Rubio et al., [9] for traditional dry fermented sausages.

Sausages at the end of the drying process as well as sausages packed in vacuum (B) after 30 days of storage had maximum score for sensory evaluation of taste and smell (5.0) and did not differ ($P > 0.05$) in relation to the score (4.9) for vacuum packed B sausages after 6 months of storage (Table 3). At the end of the storage period the best score of sensory properties (taste and smell), for both groups, had sausages packed in vacuum.

Furthermore, during the entire period of storage B sausages had significantly ($P < 0.05$) higher score for sensory evaluation of taste and smell, compared to A sausages. The results of sensory evaluation are correlated with oxidative changes in these sausages, as it could be noted that the sausages with lower MDA (B) had better score for taste and smell compared to sausages with higher MDA (A) content. So, sausages produced from cold meat and packed in vacuum had optimal sensory properties of taste and smell even after 6 months of storage. Sausages at the end of the drying process as well as sausages packed in vacuum (B) after 30 days of storage had maximum score for sensory evaluation of taste and smell (5.0) and did not differ ($P > 0.05$) in relation to the score (4.9) for vacuum packed B sausages after 6 months of storage. At the end of the storage period the best score of sensory properties (taste and smell), for both groups, had sausages packed in vacuum.

Table 3 Sensory characteristics in traditional sausage (*Petrovská klobása)*

SAUSAGE		A	B
90 day		4.3±0.13Ae	5.0 ± 0.08Bc
120 day	Unpacked	4.1±0.10Ad	4.8±0.04Bb
	Vacuum	4.0±0.00Acd	5.0±0.05Bc
	MAP	3.9.±0.08Ac	4.8±0.08Bb
270 day	Unpacked	3.1±0.16Aa	4.7±0.09Ba
	Vacuum	3.5±0.28Ab	4.9±0.09Bc
	MAP	3.2±0.11Aa	4.8±0.04Bab

[AB] indicates significant difference within row ($P < 0.05$) [a-e] indicate significant differences within column ($P < 0.05$)

IV. CONCLUSION

During the entire period of drying and storage the intensity of oxidative changes in the sausages produced from cold meat was significantly lower ($P < 0.05$) comparing to sausages produced from hot meat. Packaging method (vacuum or MAP) resulted in lower

intensity of oxidative changes in both groups of sausages. Sensory scores for taste and smell of sausages produced from cold meat and packed in vacuum were the highest, and remain the same ($P > 0.05$) during storage period. Finally, it can be concluded that *Petrovská klobása* produced from cold meat and packed in vacuum or MAP can be stored successfully for a long time (6 months).

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