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A COMPARATIVE STUDY OF CONVENTIONAL AND ARTISANAL SALAMI BASED ON THEIR PHYSICO-CHEMICAL, AND HISTOLOGICAL CHARACTERISTIC

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Abstract

Most conventionally produced salamis are characterized by typical characteristics of preserved meat, including colour, flavour, and significant concentrations of residual nitrates. This paper compares the physical, chemical, and histological characteristics of some salamis obtained conventionally and artisanally in Romania. Based on the results of the physicochemical evaluation, the raw-dried, boiled, and smoked products salami that was analysed fall within the requirements of Order 560/2006, but there are significant differences between samples taken from different producers. The integrity parameters of premium products correlate with significant fluctuations in quality. It is important to note that since these are commercial products, they do not have a manufacturing and storage history. Despite this, our study suggests that: there is a large variation between traditionally and artisanal processed salamis. Compared to commercially produced products that were nitrite-treated conventionally, the amount of residual nitrite in most artisanal products was lower at sampling time thus, nitrites are introduced into most of these products indirectly, through components of other ingredients. According to the results of the histological examination, abundant blood vessels, connective tissue, adipose tissue, and nerve fibres were present. It has been stated that these occasional findings are inevitable as a result of the industrial processes."

Key words*: salami, quality, integrity, microscopic structure, artisanal.*

INTRODUCTION

It has become common to use the term "artisanal food," but the concept has many aspects, and there are no definitions that precisely describe it. Almli et al., 2011. By referencing the geographical origin or traditional production methods of products, EU legislation (EC, 2006 b; EC, 2012) identifies "traditional" foods. Additionally, the Euro FIR FP6 Network of Excellence has provided a definition of traditional foods, which includes statements about traditional ingredients, traditional composition, and traditional manufacturing and/or processing methods (Almli et al., 2011; Guerrero et al., 2009).

Essentially, salami is a ground meat product made from fat and meat that is sold raw or unheated (Dong-Gyun et al., 2020). The quality and manufacturing methods of these products differ. The purpose of this paper is to compare the physico-chemical and histological characteristics of some salamis obtained conventionally and artisanal in Romania. In producing salami, there are several internal product characteristics that affect its color, taste, aroma, and texture. These indicators include water activity (Aw), pH value, protein, presence of nitrite and nitrates, and weight loss during fermentation (Feiner, 2006). In Europe, Italy produces the most traditional products and foods with a protected designation of origin (PDO) or a protected geographical indication (PGI), followed by France, Spain, Portugal, and Greece (Rocato et al., 2017). For Romanians, the most famous salami assortments from the raw-dried category are Banatean salami, Haţeg salami, and Sibiu salami (Mencinicopschi, 2006). Regarding the increasingly intensive and industrialized nature of traditional meat production and more generally food production (McEachern and Willock, 2004; Abrams et al., 2010). Consumers are concerned about the health, environmental, and social impacts of this trend, as well as the widespread use of "Without" labels (McEachern and Willock, 2004; Schleenbecker and Hamm, 2013). "Without antibiotics," "without chemical

additives," "without preservatives", and other similar claims can mislead consumers into believing that conventional products pose health and safety risks (Abrams et al., 2010). Investigation of the production process revealed that the drying-maturing process used in the production of traditionally fermented sausages varies widely among manufacturers. As a result, several authors have previously reported a wide range of pH and aw (water activity) values during the different stages of the production process of artisanal salami and traditional soppressata (Chevallier et al., 2006; Gounadaki et al., 2008; Lebert et al., 2007). There is a lack of studies in the bibliography related to the processes of product extraction in the artisanal system, and a lack of knowledge and expertise has been identified as one of the major shortcomings of the system (Zanardi E. et al., 2010). The small number of processing and transaction stages, as well as the employees involved, allow for effective communication and control (Verraes et al., 2015). A cohort study in the Veneto region of Italy investigated the production of artisanal salami and the microbiological hazards associated with these products, providing an additional useful tool for monitoring the artisanal production process and managing microbiological hazards (Rocato et al., 2017).

MATERIALS AND METHODS

Physico-chemical and histological analyses were conducted on 24 samples from the commercial chain during the validity period. These samples came from the following categories: boiled and smoked meat products (n = 12), and raw-dried meat products (n = 12). We measured the moisture, protein, lipids, nitrite content, salt (NaCl), and freshness analysis TVBN (total volatile basic nitrogen) in accordance with the standard SR ISO of the International Organization for Standardization, and the Association of Official Analytical Chemists (AOAC). The determination of moisture was carried out by drying in the drying-stove method and expressed as a percentage, according to and SR ISO 1442:2010. The nitrites content of foodstuffs is expressed in mg per 1kg product (ppm) and is regulated by - ISO 2918:1975 (last revised in 2018), using a spectrophotometer at 538 nm wavelength. The nitrate and nitrite content of meat products after the enzyme reduction of nitrates in nitrites, providing for a maximum value of 150 mg/kg for meat products. The Kjeldahl Method (AOAC, 2000 Method 928.08); and SR EN ISO 937:2007 was used to determine the raw protein content (CP=crude protein) and the extraction Soxhlet method and SR ISO 1443:2008 was used to determine the percentage of fat (ether extract) (AOAC,2000, Method 960.39). The determination of the sodium chloride content complied with the specification of SR ISO 1841-1: 2000 Part 1: Volhard method. The freshness was assessed by determining the total volatile basic nitrogen according to SR 9065-7:2007.

Statistical data analysis

The data obtained were statistically processed using MedCalc Statistical Software version 19.1.5 (MedCalc Software bv, Ostend, Belgium; https://www.medcalc.org; 2020). The statistical
tests used were: two-tailed t-test for an independent sample, one-tailed t-test for one sample, and the Wilcoxon nonparametric test for situations where the data were not normally distributed. The Shapiro-Wilk test was used to check data normality. The significance threshold is p = 0.05. The statistical indicators used in this study are the arithmetic mean, the median, the standard deviation (SD) of the mean, the standard error of the mean, the relative standard deviation, the minimum value, and the maximum value of the data set.

RESULTS AND DISCUSSIONS

a) Physico-chemical analyses

Dried raw meat products category

Statistical analysis of salamis in the category of raw dried products shows that the average value obtained for moisture content ranges from 27.62 to 31.92%, with the average moisture value of 35.02% being statistically significant (P = 0.0002; Table 1) with a probability of 95% above the value prescribed by the 2006 regulation MADR 560. The highest humidity was highlighted for sample B 24 (35.02%). These values are lower than those reported in the literature for similar meat

products (Zanardi, 2010; Van Schalkwyk et al., 2011; Demeyer et al., 2007; Ockerman et al., 2007; Conte A. et al., 2012;). We assume that the mean value of the salami sample in the category of raw dried products exceeds the maximum legal value (35%) for the parameter moisture. Determination of total fat content is performed only if limits for this indicator are included in quality standards or technical norms. If this is not the case, the free fat substances are determined. The results of the fat content gave values between 32.09 and 42.51%, with a probability of 95%. Statistical analysis showed that the average value of 37.30% is significant in comparison (P = 0.0005; Table 1) with the value prescribed by the standard. All samples are within the maximum values (50%) for this category of meat products. The obtained results indicate a higher lipid content than those obtained by other authors, such as Dobrinas S. et al. (2013), who reported values for lipid content ranging from 18.5 to 31.1% for raw dried pork and sheep meat products. The nitrite content obtained for the samples studied ranged from 0.24 to 1.12 mg/100 g, with an average value of nitrite content of 0.68 mg/100 g, significantly (P = 0.0005; Table 1) higher than the value required by Regulation MADR 560/2006. The values obtained are almost identical to those of other authors (Păduraru et al., 2010), who report values between 1-6 mg/kg, Dobrinas et al. (2013), and Isaconi et al., 2018) report 0.79-0,38 mg/kg (Isaconi et al., 2018). The value obtained for sodium chloride is reasonable, provided that the maximum value of 6% provided for in the legislation. All samples fell within the legal requirements and had an average content of 4.82%, with a confidence interval of 95% between 3.82% and 4.74%, with the average value of 4.82% statistically significant (P < 0.0001; Table 1) above the value prescribed by the standard for salami samples from the category of raw dried products. The values for sodium chloride content reported in the literature for meat preparations of the same category are similar, ranging from 3.8 to 5.5% (Zanardi, 2010; Van Schalkwyk et al., 2011; Demeyer et al., 2007) for samples of pork and sheep products.

The freshness of the samples, evaluated by the determination of TVBN, was adequate, not exceeding the maximum value of 200 mg NH3/100 g. The values obtained ranged from 46.36 to 49.90 mgNH3/100 g, with an average of 73.99%, the data being statistically significant (P < 0.0001; Table 1). A significant difference was observed in the amount of TVBN in samples B15 (34.00 mg NH3/100 g) and B18 (129.48 mg NH3/100 g). Another study (Jude et al., 2011) reported a similar variation in values for similar products, ranging between 63.59 and 176.3 mg NH3/100 g. For pork and sheep products, Dobrinas et al. (2013) reported lower than average values for the easy-to-hydrolyze nitrogen, which ranged from 17.3-32.03 mg NH3/100 g, with an average of 26.76 5.71 mg NH3/100 g.

Smoked and boiled meat products category

It was determined that the mean moisture content of boiled and smoked salami products was between 51.88% and 60.41% with a 95% probability based on the sample (n = 12). Through statistical tests, it was found that the mean value of 56.14 of the sample (P = 0.0004; Table 1) was significantly different from the value specified in the MADR 560 regulation (max. 66%). After examining the 12 samples purchased in artisanal shops, we can conclude that the boiled and smoked salami products do not exceed the maximum value (66%) provided by the legislation. In the analysis of the smoked and boiled products, we find that the average value of 15.27% obtained for the protein is statistically significant (P = 0.0005; Table 1) above the value required by legislation (min. 11%), with a confidence interval of 12.65 - 17.89%. We consider that the mean value of the salami sample in the category of boiled and smoked products is above the minimum value prescribed by the standard.

Compared with the maximum value prescribed by the regulation (30%), the determined average fat content of salami in the category of cooked and smoked products is 19.87, with a 95% confidence interval between 15.36 and 24.58%. The determined fat content value exceeds the maximum value by a significant amount (P = 0.0151; Table 1). We consider that the mean value of fat content is appropriate for the category of smoked and cooked products.

The nitrite content of the tested samples was between 1.20 and 2.52 mg/100 g with a 95%

probability. The average value was 1.86 mg/ 100 g based on statistical analysis. Table 1 shows a significant difference (P = 0.0001) from the value prescribed by MADR 560. In our view, the salami samples from the category of smoked and cooked products are significantly lower than the maximum values (max 150 mg/100 g) prescribed for this category.

The mean value obtained for TVBN (36.73 mg/ 100 g with a confidence interval between 34.81 mg/100 g and 38.64 mg/100 g) is statistically significant (P = 0.0018; Table 1). It can be said that the average value of 36.73 mg/ 100 g of salted and double smoked salami products corresponds to the conditions in which the expected value is maxed at 45 mg/100 g).

As for the sodium chloride content, a maximum of 3% NaCl is allowed for smoked and boiled products. All samples fell below the legal requirements. With an average content of 2.35% and a confidence interval between 2.00-2.59%, the average value of salt content is significantly (P = 0.0018; Table 1) higher than the value prescribed by the standard.

Table 1. Descriptive statistics for moisture, protein, fat, salt, nitrites concentrations, protein ratio and TBVN for the salami type products

Type of samples examined	Type of analysis	Order MADR 560/2006	Confidence interval 95%	Min (%)	Max (%)	Mean ± SE	Value P. (probability) *
Salami from the category of raw dried products n = 12	Moisture	**Max 35**	27,62-31,92	25,66	35,02	29,77±0,97	P = 0,0002
	Protein content	**Min 16**	20,81-25,79	14,56	25,83	22,90±0,97	P = 0,0010
	Fat	**Max 50**	32,09-42,51	12,86	46,66	37,30±2,36	P=0,0005
	Nitrite	**Max 150**	0,24-1,12	0,27	2,85	0,68±0,20	P = 0,0005
	TVBN	**Max 200**	46,36-49,90	34,00	129,48	73,99±9,58	P < 0,0001
	Salt	**Max 6**	3,82-4,74	3,02	5,35	4,82±0,20	P < 0,0001
Salami from the category of boiled and smoked products n = 12	Moisture	**Max 66**	51,88-60,41	47,00	65,21	56,14 ±1,93	P = 0,0004
	Protein content	**Min 11**	12,65-17,89	11,08	24,43	15,27 ±1,19	P = 0,0005
	Fat	**Max 30**	15,36-24,58	9,18	29,83	19,97 ±2,00	P = 0,0151
	Nitrite	**Max 150**	1,20-2,52	0,42	3,15	1,86 ±0,29	P < 0,0001
	TVBN	**Max 45**	34,81-38,64	33,00	42,30	36,73 ±0,86	P < 0,0001
	Salt	**Max 3**	2,00-2,59	1,5	3,5	2,35 ±0,49	P = 0,0018

* The mean of the population from which the sample with value imposed by order 560/2006 was compared. The bilateral t-test was performed for each of the two types of products separately

b) Histological analyses

Microscopically, in some sections of the raw dried products (salamis), various tissues were highlighted: striated muscle tissue, various types of connective tissue in abundance, fatty tissue, vascular structures, and nerve filaments (Figure 1). In the sections of the raw dried products stained with the conventional technique hematoxylin-eosin (reds), the homogeneous appearance of muscle fibers and their non-uniform distance from the endomysium can also be observed, the appearance is related to the process of dehydration after treatment with salt. The cell morphology is moderately preserved in the center, while the periphery of the product is completely distorted (Figure 2).

In sections of boiled and smoked products (Figure 3), most muscle fibers are homogeneous, have a broken sarcolemma, sometimes with lysed nuclei. Occasionally, streaks are seen in the sarcoplasm. Adipocytes retain their cellular outlines, with most of them lacking nuclei. Plant fragments of spicules and evenly distributed basophilic amorphous masses are observed throughout the thickness of the product. Fiber integrity is moderately preserved. Microscopically, no parasitic, fungal, or bacterial elements were detected in any product category. The products of the meat processing industry do not consist exclusively of materials of animal origin. Simple microscopic observation using conventional H&E (hematoxylin - eosin) staining easily identifies components of plant origin in their traditional form (Pospiech M. et al., 2011). Vanha and co-workers argue that the identification of constituents in meat products combined with an estimate of their actual quantity allows monitoring the quality of meat

products using the same staining (Vanha et al., 2011).

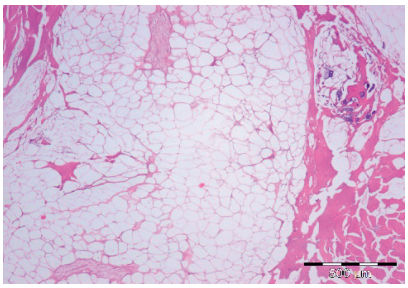

Figure 1. Dry summer salami, HE stains (Ob. 4x), striated muscle tissue, various types of connective tissue in abundance, fatty tissue, vascular structures, and nerve filaments

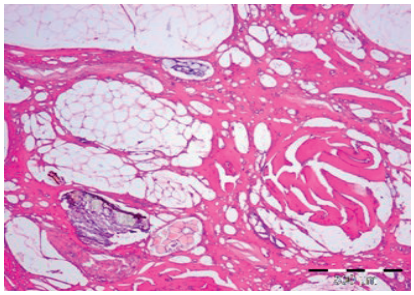

Figure 2. Banat salami - dry raw product HE stains (Ob.4x). The cell morphology is moderately preserved in the center, while the periphery of the product is completely distorted

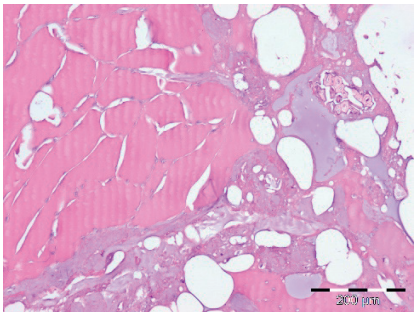

Figure 3. Rustic Salami - boiled and smoked product, HE stains (Ob. 10x) - muscle fibers are homogeneous, have a broken sarcolemma, sometimes with lysed nuclei

CONCLUSIONS

According to the physic-chemical analysis, raw, dried, boiled, and smoked products complied with Regulation 560/2006, but there were significant differences between samples taken from different producers.

Quality differences between high-quality products correlate with changes in integrity parameters.

Our study suggests the following: Artisanal and conventionally processed salamis differ significantly.

We found that residual nitrite levels were lower in artisanal products than in products made with conventional nitrite additions. Therefore, nitrites are introduced indirectly into most of these products through other ingredients. The results of the histological examination showed the presence of blood vessels, various types of connective tissue, adipose tissue, and nerve fibers in abundance. These occasional findings were described as "unavoidable in view of the technological process."

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