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PHYSICO-CHEMICAL AND SENSORY EVALUATION OF THREE TYPES OF PORK MORTADELLA MANUFACTURED IN THE IULS MEAT PROCESSING MICROSECTION

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Abstract

The objective of this study was to develop and characterize three batches of mortadella made at the IULS meat processing microsection from three anatomical regions of the pork carcass: loin, tenderloin, and chop. The proportion of ingredients introduced were: 80% meat, 15% pork fat, and 5% ice flakes. The mortadella samples were characterized physicochemically in terms of moisture, lipid, protein, and collagen content, as well as sensoryly to determine the perception of a group of evaluators on sensory attributes (appearance, color, aroma, taste, texture, general acceptance). The batch of mortadella obtained from tenderloin had the highest moisture and protein content and the lowest lipid percentage compared to the batches obtained from loin and chop. The anatomical region significantly influenced the color parameters of the mortadella, with the L3MC batch showing the most intense lightness, the highest value of the b parameter, and the lowest red intensity compared to the other two samples. Regarding the sensory evaluation, the batches were scored between 6.27-8.03 for the sensory attributes, and the ranking of the overall acceptance of samples was: L1MS, L2MM, L3MC.*

Key words*: anatomical regions, chop, loin, mortadella, pork, tenderloin.*

INTRODUCTION

Meat is an important source of essential nutrients for the human body. These nutrients include proteins, fats, vitamins, and minerals, which perform various functions in the human body. However, emulsified products are perceived by consumers as unhealthy due to the contribution of saturated fats, additives, and very little or no fibre or calcium in the diet (Feiner, 2006; Horita et al., 2011; Saldaña et al., 2018). In general, emulsified products contain 20-35% fat and 2.2-2.5% salt (Câmara et al., 2020), with fat being a food component that contributes to the sensory perception of the product as it influences the balance, intensity, and release of flavors by affecting the distribution and migration of flavor compounds. Moreover, fat is an element that improves texture and appearance and enhances the feeling of satiety during meals (Cáceres et al., 2004).

Mortadella is an emulsified product known and consumed worldwide, defined as a boiled emulsified product obtained from the meat of various species of animals and introduced into natural or artificial membranes of various shapes and sizes (Muraoka et al., 2019; Biasi et al., 2023). Mortadella is a type of sausage originating from Italy, more precisely from the Emilia-Romagna region. Typically, mortadella is made from finely minced selected pork and beef meat, mixed with small pieces of fat, seasoned with various spices such as pepper, nutmeg, and coriander, and then wrapped in a thin natural membrane. Over time, the recipe and production process for mortadella have evolved, and today there are several varieties of this product, including some that include food additives or other ingredients. However, traditional Italian mortadella is still made today according to the same centuries-old recipe, using simple ingredients and traditional production methods (Olkiewicz & Moch, 2008; Guerra et al., 2011; Doménech-Asensi et al., 2013; Alda et al., 2021). Nowadays, considering the evolution of consumer tastes

and the nutritional demands they have from food products, mortadella recipes are becoming more and more oriented towards reducing fat and salt content (Barbieri et al., 2013; do Santos et al., 2020).
Pre-slaughter factors such as species, age, type of feeding, slaughter conditions, and post-slaughter conditions like the rate of occurrence of rigor mortis and method of bleeding all have an impact on final meat quality (Maher et al., 2004).
Moreover, the carcasses of slaughtered animal species comprise several muscle groups whose quality differs in terms of chemical composition, technological quality, and commercial value. In this context, the study investigated the influence of anatomical regions from different quality classes on the physicochemical quality of final products and their influence on consumer preferences.

MATERIALS AND METHODS

The study was carried out at the University of Life Sciences "Ion Ionescu de la Brad" in Iasi; the mortadella was obtained in the Meat Processing Workshop, and the analyses were carried out in the Meat and Meat Products Technology Laboratory.
To achieve the proposed aim, an experimental protocol was developed based on which three batches of mortadella were made from pork meat from three anatomical regions classified in different quality classes: tenderloin, chop, and loin.
The production process of the batches of mortadella involved the introduction of the following raw materials: 80% quality I pork, with loin for batch 1 (L1MS), tenderloin for batch 2 (L2MM), and chop for batch 3 (L3MC); 15% fat; 5% ice flakes. The meat was pre-salted with 2% salt, and black pepper (5 g/kg), garlic powder (10 g/kg) and paprika (2 g/kg) were used for seasoning.
The raw materials were prepared for mincing, for which a grinding machine with a small working capacity (Wolf) was used (with a sieve of 3 mm diameter). The composition obtained was minced until a fine, homogeneous paste (bradt) was obtained, to which ice flakes were added after a few rotations to stop the temperature of the paste from rising during the operation. Throughout the process, the temperature of the paste is checked with a vertical thermometer to prevent it from rising above 13°C. The fat is blanched for 15-20 minutes at a temperature of 80-85°C and then minced through a 10-12 mm diameter sieve.
After primary processing, the raw materials are weighed and then mixed with the fat and spices until evenly distributed in the paste structure. The resulting paste is placed in polyamide filling membranes of 50 mm diameter, which have been previously hydrated to form elasticity.
The heat treatment carried out was the same for the three batches of products; the steps are shown in Table 1.

Table 1. Heat treatment scheme of the mortadella batches

Heat treatment stage	Time	Temperature inside the cell	Temperature in the thermal centre	Humidity
	minute	°C	°C	%
Air drying	30	65	50	60
Boiling	-	78	69	99
Hot air drying	10	78	69	60

The finished products obtained were subjected to physicochemical and sensory evaluations in the Meat and Meat Products Technology Laboratory and the Sensory Analysis Laboratory.
The pH values were determined using a HANNA HI99163 digital pH meter, which uses an amplified pH electrode with a built-in temperature sensor.
The color of mortadella samples was determined using a Chroma Meter CR-410 colorimeter (Konica Minolta Inc., Japan) in the CIELAB scale. The light source of the device was D65, the observation angle was 10°C, and the aperture of the measuring cells was 50 mm. The scale used for the color reading was L*, a*, and b*.

The chemical evaluation involved the determination of proximate composition (moisture, fat, protein, and collagen) using a FoodCheck analyzer (a spectrophotometer that uses infrared light rays). For the sensory evaluation of mortadella samples, 55 potential consumers were selected from students at the University of Life Sciences. The panel ranged in age from 20 to 31, with 62% being female and 38% being male. The sensory evaluation involved the application of a hedonic acceptance test whereby participants were instructed to evaluate the three formulations of pork mortadella through the attributes of appearance, color, aroma, taste, texture, and overall acceptance. A 9-point scale (1 = extremely unpleasant, 5 = neither pleasant nor unpleasant, 9 = extremely pleasant) was used for scoring. The presentation of the samples was in pieces of approximately 3 cm thickness, coded with three-digit codes.

The mean values obtained for the proximate composition, colour parameters and acceptability test were compared using analysis of variance (ANOVA) followed by Tukey's test at 5% significance level ($p < 0.05$), using XLStat software (Addinsoft version, 2022).

RESULTS AND DISCUSSIONS

The chemical composition and mean pH values determined for the batches of mortadella produced are shown in Table 2. Significant differences were observed between the batches made for all five parameters evaluated ($p < 0.05$). The highest moisture content was found in the batch of mortadella made from the tenderloin (L2MM, 66.28%), followed by the batch from the loin (L1MS, 63.46%), and finally by the batch from the chops (L3MC, 63.21%). These findings are comparable to those from Guerra et al. (2011), who described the moisture content of goat mortadella with 10% fat at a level of 65.75%. Similar results were reported by Viuda-Martos et al. (2010), who presented a water content of 65.62% in a control batch of mortadella formulated with 50% lean pork meat and 50% pork backfat.

Regarding the fat content, the L2MM samples had the lowest mean value (12.48%), with the L1MS (16.48%) and L3MC (17.02%) batches coming in second and third, respectively, with similar mean percentages. A study conducted by García et al. (2006) reported a fat content of 12.71% determined in a reduced-fat mortadella product, a percentage similar to the result obtained for batch L1MS. Fat content plays an important role in the technological process of production, as well as in the perception of sensory and instrumental properties of the texture of mortadella-type products (Saldaña et al., 2015; Alda et al., 2021).

The protein content for the three batches of mortadella was in the range of 18.26 ± 0.02 (L3MC) to 19.34 ± 0.02 (L2MM, Table 2). These results could be related to the percentage of fat in the three batches, since the composition of the batch made from tenderloin, which presented the lowest amount of fat (implicitly the highest percentage of water), identified the highest percentages of protein. The other two batches also showed a decrease in protein content and an increase in fat content. The protein content found in the three assortments of mortadella manufactured was higher compared to the values reported by Barbieri et al. (2013), who analyzed 39 samples of mortadella from the Italian markets and found protein contents that varied between 12.25% and 16.85%.

Collagen is a stromal protein of industrial importance because it gelatinizes during cooking, contributing to the texture of the product. The collagen content was expressed as a percentage of protein content. The results obtained for the collagen content of the products revealed percentages directly proportional to the amount of protein content (Table 2); thus, the highest percentage of collagen was identified in batch L2MM.

The salt content of the products did not differ significantly ($p > 0.05$), as all three batches were salted in the technological process of production with the same percentage of salt.

Regarding the pH of mortadella samples, the differences in values were distinctly significant ($p < 0.05$). The highest pH value was recorded for the batch of mortadella made from the tenderloin, while the batches made from loin and chops showed similar pH values, the differences being not significant.

Color is an extremely important quality attribute, as it is the first impact that determines consumers' initial perception of the food product.

Table 2. Analysis of the chemical composition and pH of the mortadellas batches

Parameters	L1MS $\bar{x} \pm s_x$	L2MM $\bar{x} \pm s_x$	L3MC $\bar{x} \pm s_x$	p-value
Moisture (%)	63.46 ± 0.14b	66.28 ± 0.07a	63.21 ± 0.09b	**<0.0001*****
Lipid (%)	16.48 ± 0.16ab	12.48 ± 0.06c	17.02 ± 0.09a	**<0.0001*****
Protein (%)	18.45 ± 0.03b	19.34 ± 0.02a	18.26 ± 0.02b	**<0.0001*****
Collagen (%)	16.76±0.04	17.48 ± 0.02	16.52 ± 0.04	**<0.0001*****
Salt (%)	1.28 ± 0.06	1.26 ± 0.04	1.28 ± 0.04	0.178^{ns}
pH	6.11 ± 0.06b	6.36 ± 0.04a	6.07 ± 0.03b	**0.001****

$\bar{x} \pm s_x$ – Mean value followed by standard deviation. Mean values in the same line with different letters are significantly different by the Tukey test ($p<0.05$).

The results obtained for the color parameters lightness (L*), redness (a*), and yellowness (b*) are presented in Table 3. All three color parameters evaluated showed highly significant differences ($p < 0.05$) between batches of mortadella. The mortadella samples obtained from the loin (L1MS) had the lowest lightness (L*) (59.96 ± 0.65, $p < 0.05$), followed in ascending order by the mortadella batches from the tenderloin (L2MM) and the chop (L3MC). A more intense red hue (a*) was also observed in the samples with the lowest L* lightness, values that decreased with increasing lightness. Regarding the values of the parameter b* (yellowness), these were directly correlated with the lightness, as the yellow coloration was more intense in the samples of lot L3MC with the highest lightness.

Thus, the type of meat used may influence the colour parameters (lightness, redness and yellowness) of each lot of mortadella, mainly due to the concentration of myoglobin present in the respective anatomical region (Alda et al., 2021).

Table 3. Instrumental colour of the mortadellas batches

Parameters	L1MS $\bar{x} \pm s_x$	L2MM $\bar{x} \pm s_x$	L3MC $\bar{x} \pm s_x$	p-value
L*	59.96 ± 0.65	63.23 ± 0.23	68.04 ± 0.24	**<0.0001*****
a*	13.816 ± 0.66	11.23 ± 0.34	7.93 ± 0.25	**<0.0001*****
b*	11.186 ± 0.16	12.49 ± 0.30	13.97 ± 0.17	**<0.0001*****

ANOVA Tukey test: ns = $p > 0.05$; *** = $p < 0.001$

Sensory evaluation of the mortadella batches revealed significant differences ($p<0.05$) in the attributes of appearance, color, aroma, taste, texture, and overall acceptance. Among the three product batches, higher scores were recorded for the L1MS batch, which was perceived by the participating evaluators as the most balanced product in terms of appearance and color. The same sample, L1MS, scored the highest for texture, which correlated with the percentage of fat identified in the product composition. Therefore, the higher amount of fat resulted in a higher appreciation of the texture of the product, the perception of a fine texture, and the composition being better bound and compact. Also, aroma and taste were scored higher for samples with a higher composition of fatty substances. The overall acceptance of the batches scored between 6.67 ± 1.06 (L3MC) and 7.83 ± 0.65 (L1MS), indicating that the products were considered acceptable by the evaluators.

Table 4. Sensory evaluation and acceptability of the mortadellas batches

Sensory parameters	L1MS $\bar{x} \pm s_x$	L2MM $\bar{x} \pm s_x$	L3MC $\bar{x} \pm s_x$	p-value
Appearance	7.53 ± 1.01a	6.33 ± 0.92b	6.43 ± 0.94b	**<0.0001**
Color	7.83 ± 1.26a	6.37 ± 0.85b	6.27 ± 0.91b	**<0.0001**
Aroma	7.87 ± 0.94a	6.90 ± 1.14b	7.12 ± 1.18c	**<0.0001**
Taste	8.03 ± 0.93a	7.47 ± 0.77b	7.73 ± 1.04c	**<0.0001**
Texture	7.70 ± 0.84a	6.87 ± 1.17b	6.57 ± 1.01c	**0.0001**
Overall acceptance	7.83 ± 0.65a	6.97 ± 1.03b	6.67 ± 1.06c	**<0.0001**

$\bar{x} \pm s_x$ – Mean value followed by standard deviation. Mean values in the same line with different letters are significantly different by the Tukey test ($p<0.05$).

CONCLUSIONS

The batches of mortadella produced in the IULS meat processing plant showed positive quality characteristics. The proximate composition of the samples followed the anatomical regions used in the production process. The batch of mortadella made from tenderloin (L2MM) differed significantly from the other two batches by having a higher moisture content and the lowest lipid content. In terms of the instrumental color of the samples, the L1MM batch made from the tenderloin was found to have a lower lightness, and it also showed the most intense color of red. From a sensory perspective, all three batches were positively rated by the evaluators, with the overall sensory acceptance being highest for the L1MS batch.

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