INFLUENCE OF SALTING METHOD ON QUALITY PARAMETERS OF SHEEP PASTRAMI PRODUCED AT U.S.V. IAȘI THROUGH TRADITIONAL AND EXTENSIVE METHODS

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Abstract

The present work aimed to produce and evaluate the sensory and physicochemical quality of three different types of sheep meat (pulp) pastrami. The difference between them was represented by the type of salting used: dry salting, wet salting by immersion, and wet salting by injection. The production of the three types of pastrami was carried out in the meat processing workshops of the University of Life Sciences in Iași. The three batches of pastrami were subjected to analyses to check their quality. Initially, the sensory quality of these products was analyzed using the CATA (Check-All-That-Apply) test to determine consumer perception. Following the first qualitative analysis (sensory analysis), analyses were carried out to determine the physicochemical quality of the products studied, including pH, instrumental determination of colour, texture, and chemical composition. The results of the study showed significant differences between batches of pastrami in terms of fat, moisture, protein, collagen, and salt content (p > 0.05). Salt had a significant impact on the colour and texture characteristics of meat products. Regarding the colour of the samples, the analyzed data show that meat samples subjected to L1DS dry salting (45.514±0.704) and L2WS wet salting (47.422±0.704) exhibited a more intense red hue and a more pronounced yellow hue compared to the L3BI brine injection-processed sample (48.274±0.704). In terms of sensory evaluation, the samples were assessed for attributes such as colour, texture, flavour, and overall quality. The injection-salted pastrami batch performed best in terms of overall quality and flavour.

Key words: *sheep pastrami, types of salting, quality evaluation, meat products*

INTRODUCTION

The world population is projected to reach 8.6 billion in 2030 and 9.8 billion in 2050 [1]. According to a recent report by the Food and Agriculture Organization of the United Nations (FAO) in 2011, meat consumption is expected to increase by almost 73% [2].

Trends in production and consumption levels per person, as well as consumption patterns, lead to an expectation of substantial growth in sheep meat consumption in developing countries, where protein intake is currently above the minimum recommended level [3,4].

Despite not being the most consumed meat in the world, the decade from 1994 to 2004 saw a notable increase of 75% in sheep production and 42% in goat production, with this trend continuing until 2018 [5]. Countries with a long tradition of sheep and goat meat consumption produce a wide variety of products from these species, such as hams, sausages, pates, and other processed items. Many of these products are based on ancient methods of preserving meat, which was essential when there were no other means of preservation besides salting, air-drying (to reduce the water content of the meat), or smoking. Nowadays, meat processing is not only

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about the need for preservation but, more importantly, it caters to consumer demand and acceptability for meat products, enhancing palatability and flavour characteristics [6].

Salt is often referred to as the "queen of all flavours." It plays an essential role in people's daily diets and the food industry. In particular, sodium chloride has been widely used as a food additive and preservative for thousands of years to improve food quality, including texture, safety, and flavour [7,8,9].

Meat, in its natural state, is relatively low in sodium, containing only 50-90 mg of sodium per 100 g [10]. However, the addition of sodium chloride, which contains about 40% sodium, significantly increases the sodium content of meat and meat products during processing. Estimates of dietary habits suggest that about 20-30% of the usual salt consumption in Western countries comes from meat and meat derivatives [11]. These products can contribute up to 25% of total sodium intake [12]. Salt has repeatedly been shown to play a crucial role in food perception and acceptance [13]. Both colour and taste are essential sensory qualities that generally affect acceptability and thus need to be considered in conjunction. Concerning taste, the flavour of meat preparations becomes more pronounced with increasing amounts of salt and nitrite, with salt having a greater effect [14]. The sensory function of salt is not limited to generating a salty taste; it also modifies the perception of other tastes and flavours [15].

Consumers' perception of salty and sweet tastes is influenced by salt levels. A European study determined that salty taste is the main trait related to consumers' overall satisfaction with dried meat [16].

MATERIAL AND METHOD

The experimental batches were produced at the Meat Processing Workshop of the "Ion Ionescu de la Brad" University of Life Sciences in Iași. To perform sensory characterization of the studied batches, we established an experimental protocol comprising the technological sheet for batch production and a sensory evaluation questionnaire. The pastrami varieties were prepared using the ingredients and concentrations outlined in Table 1.

Table 1 Types of salting and formulation of sheep pastrami

Batch code	Salting type	Ingredients (%)			
		Salt	Garlic powder	Sweet paprika powder	Pink pepper powder
L1DS	Dry	2	8	5	4
L2WS	Wet (immersion)	10			
L3BI	Wet (injecting)	2			

The manufacturing process involved several distinct steps to produce pastrami, with the sole difference among batches being the type of salting employed, along with specific parameters corresponding to the chosen salting method. The precise sequence of steps undertaken to yield the three pastrami batches is outlined as follows:

Slicing the sheep carcass to obtain the requisite raw meat (pulp) necessary for pastrami production.

Salting the raw meat using one of three distinct methods:

- Dry salting - In this method, 2% salt, relative to the quantity of meat in the batch, was uniformly distributed onto the meat pieces through thorough mixing.
- Wet salting by immersion - For this salting technique, 10% salt (as a percentage of the meat batch quantity) was dissolved in water to create a brine solution. The brining process was executed using a specialized brine boiler. Following brine preparation, the meat was submerged in the brine solution, with both components mixed through the brine boiler's mixing function.

- Brine injection involved the use of a needle injection machine to introduce a brine into the meat pieces. The brine had a salt concentration of 2% relative to the meat quantity, and the total volume of brine injected equaled 10% of the total meat batch volume.

Subsequently, the meat pieces were secured with a string at one end, employing a specialized needle designed for meat specialties.

The three salted meat batches underwent a maturation process conducted in different manners, each lasting 24 hours to ensure consistent salt absorption.

Following maturation, individual meat pieces from the three batches were immersed in a spiced bath and positioned within a stainless steel vat. Subsequently, the remaining bath was poured over the meat pieces. These meat pieces were further matured for an additional 12 hours within this bath to enhance the incorporation of the spice mixture into the meat.

The heat treatment consisted of 5 successive stages which were represented by: first rinsing, smoking, boiling, 2nd rinsing and baking. Each of these stages was carried out at different parameters, as can be seen in Table 2.

Table 2 Heat treatment scheme of the sheep pastrami

Heat treatment				
Drying 1	**Smoking**	**Boiling**	**Drying 2**	**Cooking**
t = 30-50 min.; U = 25%; T = 65°C (55°C inside the product)	t = 30-60 min.; U = 25%; T = 65°C (55°C inside the product)	t = 120 min.; U = 99%; T = 72°C (69°C inside the product)	t = 20 min.; U = 25%; T = 80°C (72°C inside the product)	t = 10 - 20 min.; U = 22%; T = 89-95°C (72°C inside the product)

t – time; U – humidity; T – temperature

Cooling of the sheep pastrami followed the completion of the heat treatment process and lasted for 6 hours at room temperature.

The final stage in the technological process of obtaining batches of sheep's pastrami involved packaging, labelling, and storage at temperatures ranging from 0 to 4°C in a cold storage facility. The batches were maintained in cold storage until the sensory and physicochemical analyses were conducted.

Chemical characterization was carried out by determining the chemical composition, including moisture, fat content, protein, collagen, and salt content. This analysis was performed using a spectrophotometer (FoodCheck analyzer) with an infrared light source.

The physical characterization of sheep trotter samples included instrumental determinations of pH, colour, and texture. The pH value was determined using a HANNA HI 99163 meat pH meter, which was directly inserted into the meat sample. The instrument was pre-calibrated using buffer solutions with known pH values (acidic solution: pH = 4.01; neutral solution: pH = 7.01). The electrode of the instrument was cleaned with distilled water between calibrations and readings to prevent any interference with the obtained results.

The colour of the samples was assessed using the handheld Konica Minolta Chroma Meter CR-410 within the CIE three-dimensional colour system. This involved measuring the colour parameters L*, a*, and b* under D65 illumination with an observation angle of 10 degrees. The instrument underwent calibration on a white calibration plate to establish standard values before measurements commenced.

Sample preparation for sensory evaluation included the segmentation of samples into roughly uniform-sized pieces, coding, and allocation to the assessors.

Sensory analysis took place in the Sensory Analysis Laboratory at the University of Life Sciences in Iași. It involved hedonic sensory evaluation conducted by a group of 12 trained assessors. These evaluators analyzed a range of sensory characteristics, including uniform colour, pale colour, brown colour, reddish-brown colour, succulence, dryness, hardness, elasticity, tenderness, presence of connective tissue, characteristic sheep meat flavour, presence of unpleasant flavours, smoke aroma, the intensity of spice flavours, presence of spice hints, meaty flavour aftertaste, greasy aftertaste, off-flavours, overall quality, superior taste, and varying levels of saltiness.

The results obtained for the physicochemical parameters and the acceptability test were subjected to an ANOVA statistical analysis to compare the mean values. Tukey's test was used at a 5% significance level ($p < 0.05$) for post hoc analysis.

RESULTS

The results for the chemical composition on lamb pastrami are presented in Table 3, with the percentage variation in fat content ranging from 4.520±0.037 (L3BI) to 8.300±0.037 (L1DS).

Table 3 Chemical composition on lamb pastrami

Samples	Fat (%)	Moisture (%)	Protein (%)	Collagen (%)	Salt (%)
L1DS	8.300±0.037[(a)]	70.540±0.029[(c)]	21.360±0.020[(a)]	19.700±0.18[(a)]	2.0±0.02[(c)]
L2WS	7.960±0.037[(b)]	70.804±0.029[(b)]	20.560±0.020[(b)]	18.840±0.018[(b)]	2.9±0.02[(b)]
L3BI	4.520±0.037[(c)]	73.720±0.029[(a)]	20.500±0.020[(b)]	18.780±0.018[(b)]	2.78±0.02[(a)]

a, b, c, - The same superscript letter within the same column means there is no significant difference between any two means ($p>0.05$).

Table 4 presents the recorded data for pH, L* value (lightness), a* value (red colour intensity), b* value (yellow colour intensity), as well as the force and energy required to cut the products following the applied procedures.

Table 4 pH, colour and texture parameters of lamb pastrami

Samples	Parameters	L1DS	L2WS	L3BI
	pH	6.408±0.040[(a)]	6.458±0.04[(a)]	6.474±0.082[(a)]
Surface colour	*L**	29.556±0.507[(c)]	31.882±0.507[(b)]	33.800±0.507[(a)]
	*a**	19.714±0.651[(a)]	16.200±0.651[(b)]	15.232±0.651[(b)]
	*b**	8.708±0.482[(b)]	13.772±0.428[(a)]	15.294±0.482[(a)]
Section colour	*L**	45.514±0.704[(b)]	47.422±0.704[(ab)]	48.274±0.704[(a)]
	*a**	22.944±0.327[(a)]	21.100±0.327[(b)]	19.490±0.327[(c)]
	*b**	8.774±0.115[(c)]	9.244±0.115[(b)]	9.712±0.115[(a)]
Texture	*Shear force (N)*	19.41±0.069[(a)]	18.290±0.069[(c)]	16.410±0.069[(b)]
	Energy needed for shearing (mj)	511.600±1.346 [(c)]	523.00±1.346[(b)]	710.314±1.346[(a)]

a, b, c, - The same superscript letter within the same column means there is no significant difference between any two means ($p>0.05$).

Table 5 presents the frequency of mentions for each attribute used in the CATA method. The questionnaire encompassed twenty-two attributes, with both significant and non-significant differences observed for one attribute. Assessors most frequently cited attributes such as brown colour, scarlet red, firm texture, elastic texture, and tender texture for sample L3BI, followed by sample L2WS and L1DS.

Table 5 Multiple pairwise comparisons

Attributes	L1DS	L2WS	L3BI
Uniform colour*	0.583 (a)	0.833 (ab)	1 (b)
Pale colour^{ns}	0 (a)	0 (a)	0 (a)
Brown colour***	1 (b)	0 (a)	0 (a)
Reddish-brown colour***	0.083 (a)	0.083 (a)	0.917 (b)
Succulent^{ns}	0.750 (a)	1 (a)	1 (a)
Dry*	0.333 (b)	0 (a)	0 (a)
Hard texture*	0.500 (b)	0.250 (ab)	0 (a)
Elastic texture*	0.667 (a)	0.917 (ab)	1 (b)
Tender texture**	0.333 (a)	0.667 (ab)	1 (b)
Connective tissue^{ns}	0.333 (a)	0.583 (a)	0.583 (a)
Characteristic sheep meat flavour^{ns}	1 (a)	1 (a)	1 (a)
Unpleasant flavour^{ns}	0 (a)	0 (a)	0 (a)
Smoke aroma^{ns}	1 (a)	1 (a)	1 (a)
Intense spices flavour^{ns}	0 (a)	0 (a)	0 (a)
Hints of spices^{ns}	1 (a)	0.917 (a)	1 (a)
Meaty flavour aftertaste^{ns}	1 (a)	1 (a)	1 (a)
Greasy aftertaste^{ns}	0 (a)	0 (a)	0 (a)
Off-flavours^{ns}	0 (a)	0 (a)	0 (a)
Overall quality*	0.667 (a)	0.833 (ab)	1 (b)
Superior taste*	0.667 (a)	0.833 (ab)	1 (b)
Moderate salty*	0.667 (ab)	0.500 (a)	1 (b)
Very salty*	0 (a)	0.333 (ab)	0.500 (b)

Attributes which frequencies differ between samples at *** $p \leq 0.001$; ** $p \leq 0.01$; * $p \leq 0.05$; ns no significant ($p > 0.05$). Values within rows with different lowercase superscripts are significantly different according to critical difference (Sheskin) paired comparisons test (at $p < 0.05$). L1DS – Dry salting; L2WS – Wet salting; L3BI – Brine injection

DISCUSSIONS

The percentage variation in fat content indicates significant differences among the analyzed samples (Table 3) (p>0.05). The lower fat content in L3BI can be explained by mechanisms such as structural compression of the tissue and protein denaturation induced by the specific salting method employed.

Water content exhibited significant differences among the analyzed samples (p>0.05), primarily attributable to the specific salting methods. In the case of sample L3BI, the higher water content is a result of the brine injection process, which retains moisture within the tissue.

In terms of protein and collagen concentration, the analysis revealed insignificant differences between the L2WS and L3BI batches. However, lot L1DS exhibited a significant increase in protein and collagen values. This increase can be attributed to the absence of water loss in the dry salting process. A similar phenomenon was observed in previous studies by Bonoco and Kurt in 2018 [17] when comparing the dry salting method with the brine injection method.

The mean pH values of the analyzed batches did not exhibit significant differences (p>0.05), with the highest results observed for L2WS and L3BI batches. This can be attributed to the higher salt concentration in these samples. Notably, wet salting processes resulted in slightly increased pH levels in the meat products.

Regarding the colour analysis of the products, assessments were conducted on both the surface and the product section. For the L* parameter on the exterior, there is an increase in lightness among the analyzed samples, with L1DS (29.556±0.507), L2WS (31.882±0.507), and L3BI (33.800±0.507), suggesting that L3BI exhibits the lightest colour on the surface.

The a* parameter represents colour intensity on the green-red coordinate axis, where lower values indicate lower red colour intensity. Consequently, L3BI (15.232±0.651) and L2WS (16.200±0.651) exhibited lower values compared to L1 (19.714±0.651), indicating a less intense red colour.

The b* parameter measures the degree of yellow or blue shade, with lower values signifying a less intense shade. We observe that L1DS (8.708±0.482) has lower values than L2 (13.772±0.428) and L3 (15.294±0.482), indicating a less intense colour and a less pronounced shade of yellow.

In terms of the cross-sectional colour of the samples, the analyzed data indicate that meat samples L1DS (45.514±0.704) and L2WS (47.422±0.704) displayed a more pronounced red hue and a more noticeable yellow hue compared to sample L3BI (48.274±0.704). These discernible variations in section colours can be attributed to the meat processing methods employed. It was also observed that the intensity of complementary colours was inversely proportional to brightness, with L3 exhibiting the highest brightness and the least intense red and yellow hues. Processing methods had a significant impact on the colour characteristics of meat products, and these differences have implications for consumers' sensory perception of the products.

Regarding the texture analysis of the samples, the obtained results indicate significant differences ($p>0.05$), offering valuable insights into their quality characteristics. For the texture parameter, both cutting force (N) and the energy required for cutting (mj) were evaluated. Notably, the L1DS sample recorded a higher cutting force (19.41±0.069), indicating a firmer texture compared to the other samples. This aspect aligns with findings in other studies, such as Gómez et al. (2020) [18], which suggest that the utilization of dry processing methods contributes to the attainment of products with a firmer texture due to volume reduction.

Sample L3BI, which underwent brine injection processing, achieved the lowest cutting force values (16.410±0.069N), suggesting a less firm texture. This can be attributed to both the effect of salt on muscle fibers and the fiber-disrupting action of the injection machine needles on the anatomical region.

The positive impact of the meat injection process is corroborated by Kim et al. (2020) [19], who demonstrate that brine injection has a beneficial effect on water retention and meat tenderness. Sample L2WS (18.290±0.069) exhibited mean values between L1DS and L3BI, indicating intermediate texture.

Regarding the energy required for cutting, sample L3BI necessitated the highest cutting energy, confirming its less dense texture, a finding consistent with the results obtained for cutting force. In contrast, the other two samples showed relatively minor differences. Sample L1DS (511.600±1.346) exhibited the lowest energy consumption for cutting, aligning with the cutting force results, while sample L2WS (523.00±1.346) displayed intermediate values between the two salting methods.

In terms of sensory evaluation, the attribute of reddish/crimson red colour holds particular significance because, in consumer perception, it is associated with freshness, signifying product quality and safety for consumption. Additionally, colour uniformity plays a pivotal role in consumer perception, as the presence of colour variations tends to have a negative connotation when this attribute is not positively valued. Consequently, the sensory analysis of the samples revealed significant differences in terms of brown and scarlet colour attributes, with L3BI scoring the highest compared to the other two samples.

Sample L1DS exhibited significant differences (0.333) for the "dry" attribute compared to the other samples. It's worth noting that this attribute isn't necessarily perceived as negative, as long as it doesn't dominate the sensory experience in dry-salted products, as stated by Schlich & Pineau (2017) [20].

The results obtained from the sensory evaluation align with the physicochemical determinations presented in Table 5, indicating a direct correlation between the results of sensory evaluation and the physical-chemical characteristics of the samples.

Regarding the flavour profile, no significant differences were observed among the analyzed samples, implying uniformity in terms of thermal processing and added ingredients.

In terms of overall quality, sample L3BI obtained the highest scores compared to samples L1DS and L2WS, with significant differences among them, recording intermediate values between the two different salting methods.

CONCLUSIONS

The salting process and the method of preparation exert a significant impact on the sensory and physicochemical quality of sheep meat products, including pastrami.

Among the experimental batches, L3BI emerged as possessing the highest sensory quality, displaying significant differences in terms of texture, overall quality, and taste. Conversely, the L1DS batch, processed through the dry salting method, yielded lower scores. The uniformity of the flavour profile did not exhibit significant differences among the samples. Therefore, the selection of the salting method and meticulous management of colour and uniformity aspects can influence consumers' perception of the quality of sheep meat products.

Aspects such as colour, texture, and pH exhibited significant variations depending on the chosen salting method. For instance, wet salting by injection resulted in a lighter colour and less firm texture compared to dry salting. Furthermore, while pH did not demonstrate significant differences between batches, there was a discernible increasing trend for wet salting.

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