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INFLUENCE OF INJECTION LEVEL AND QUANTITIES OF BRINE INGREDIENTS ON THE SENSORY QUALITY OF BEEF PASTRAMI

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Abstract

The study aimed to sensory evaluate and compare the colour, aroma, texture and taste attributes of six beef pastrami samples. The experimental batches were obtained in the Meat Processing Microsection of the University of Life Sciences Iasi and were formed to differ by two variation factors: the level of brine injected into the product (F1) and the amounts of ingredients introduced (salt/rapeseed oil/alfalfa powder) into the brine solution (F2). The most evident and significant differences (P < 0.01) were due to the increase in the percentage of brine introduced into the product. Thus, the sensory attributes for colour, aroma, texture (especially tenderness and juiciness) and saltiness were significantly influenced by the amount of brine injected. The batch that stood out with superior sensory characteristics was batch A because it showed favourable average scores for the attributes of tenderness, juiciness, elasticity, and the specific flavours of the brine additives did not negatively influence the characteristic flavour of the product.

Key words: *alfalfa powder, beef pastrami, injection, rapeseed oil, sensory evaluation.*

INTRODUCTION

Although beef consumption has been declining steadily since 2007 and is expected to fall by a further 5% by 2030, it remains the third most consumed meat worldwide after pork and poultry (OECD-FAO, 2021).
In 2021, global beef consumption was 6.27 kg per capita, while pork and chicken consumption was significantly higher at 11.76 kg per capita and 15.10 kg per capita respectively (OECD Meat Consumption, 2021).
Meat is a major source of a balanced diet that contributes to the development and maintenance of optimal physical and intellectual performance.
Beef is a nutritious source, rich in proteins with essential amino acids (with high bioavailability), minerals (especially iron), vitamins and other bioactive compounds (coenzyme Q10, carnitine, anserine, creatine) (Martini et al., 2019; Ribas-Agusti et al., 2019; Cardoso et al., 2020). Mwangi et al. (2019) state that 100 g of beef provides more than 25% of the recommended daily intake of protein, niacin, vitamin B_6, vitamin B_{12}, zinc and selenium and more than 10% of the recommended daily intake of phosphorus, iron and riboflavin.

Pastrami is a traditional and well-known meat product, which can be obtained from different species (lamb, mutton, goat, pork or beef), with different muscle structures and anatomical regions of the carcass. Before the development of the method of preservation by refrigeration/ freezing, the manufacture of pastrami aimed to preserve the meat by salting, partial drying, the addition of aromatic herbs and spices, smoking and boiling (using steam) (Ibrahim, 2001; Roșca & Roșca, 2014). The shelf life and microbiological safety of pastrami are mainly due to low water activity, drying and modification of microbial flora after maturation (Karabiyikli et al., 2015).
Although attempts are made to reduce the salt content of processed meat products to decrease its effect on hypertension (Yalçın & Şeker, 2016), sodium chloride is a multifunctional ingredient added to meat products to improve sensory properties, microbiological quality and some technical characteristics such as water holding capacity (Ruedt et al., 2022). In addition, Er Demirhan & Demirhan (2021) showed that besides antimicrobial, preservative and shelf-life extension roles, salt added to meat products also acts on textural attributes (hardness, cohesiveness, elasticity, chewiness).

Rapeseed oil is valued due to its optimal fatty acid composition with a favourable ω-6/ω-3 ratio (Wirkowska-Wojdyła et al., 2021). Shtonda & Semeniuk (2021) used vegetable oils (rapeseed, olive and sunflower) for marinating some beef and pork varieties, obtaining positive results for sensory characteristics: more tender texture, higher juiciness, pleasant aroma, taste and appearance.

Alfalfa (*Medicago sativa* L.) has become a product of interest in recent years, with the potential for introduction into human consumption, due to its content in slow-release carbohydrates, proteins, minerals and vitamins (Mielmann, 2013). Moreover, Aziz et al. (1968) demonstrated the antioxidant effects of alfalfa extract, effects attributed to its property to inhibit linoleic acid oxidation.

Consumer acceptability of meat and meat products is closely related to intramuscular fat content, fatty acid composition (polyunsaturated and monounsaturated) and sensory characteristics (colour, tenderness, juiciness, odour and flavour) (Mwangi et al., 2019). The importance of sensory analysis of food products is mainly due to the increasing influx of new products in the market, and the need for companies to evaluate and determine the attributes of new and competing food products already on the market (Schilling & Pham, 2012).

The most important sensory attributes of beef for consumers are flavour, tenderness and juiciness, mainly due to the amount of connective tissue it contains (Schilling & Pham, 2012). Thus, this work aims to evaluate the sensory attributes of six experimental batches of beef pastrami obtained by injecting two salting solutions (containing salt, rapeseed oil and alfalfa sprout powder in different amounts) at three different injection levels (10%, 20% and 30%).

MATERIALS AND METHODS

The research was based on the production of six experimental batches of beef pastrami in the Meat Processing Microsection of the University of Life Sciences Iasi and their sensory evaluation. The differentiation of the six batches was done in two steps, first by the content of the ingredients added to the injection solution and second by the level of solution injected in each batch. Thus, experimental batch A had as injection solution a liquid containing 4% salt, 5% rapeseed oil and 0.3% alfalfa sprout powder, and experimental batch B was injected with a solution containing 5% salt, 8% rapeseed oil and 0.6% alfalfa sprout powder. Three different sub lots were formed from each batch by the percentages of brine injected, hence sub lots A_1/ B_1 were injected with 10% brine solution, sub lots A_2/ B_2 were injected with 20% brine solution and sub lots A_3/ B_3 were injected with 30% brine solution.

Sample preparation

The raw material used for the pastrami was beef from adult animals purchased from a local slaughterhouse. The pieces of meat were sorted and trimmed to remove fat and connective tissue. The meat pieces were weighed before and after injection. The injection was performed in three stages for each solution formed (with 10%, 20% and 30% brine) with the INWESTPOL injection machine (10 needle version). The machine was set according to the category of meat used, at 12 strokes per minute and a pressure of 1.8 bar. After injection, the meat pieces were tied and placed on the racks for heat treatment. The heat treatment was carried out in the INDU imax500 heat treatment cell according to the following smoking programme: smoking (for 60 minutes at 82°C); smoke ignition (for 5 minutes at 82°C); smoking (for 40 minutes at 82°C); boiling (for 90 minutes at 83°C); baking (for 20 minutes at 89°C). After heat treatment, the products were cooled to reach refrigeration temperature, vacuum-packed and stored at 2-4°C until the sensory evaluation session.

Sensory evaluation

The batches obtained were sensory evaluated in terms of colour, aroma, texture and taste characteristics using a 9-point hedonic rating scale. From the descriptive sensory terminology specific for beef meat, 15 attributes were selected: colour uniformity, colour intensity, overall aroma, metallic aroma, pungent (woody) aroma, grassy aroma, rancidity, tenderness, hardness, elasticity, juiciness, acid, salty, bitter and umami taste.

The panellists were instructed how to use the hedonic scale and trained to understand the attributes assessed. The sensory evaluation consisted of three tasting sessions (three repetitions) organised to evaluate the six experimental batches. The evaluation team consisted of 8 members, four women and four men (between 22 and 27 years of age). The sensory evaluation sessions were conducted in the Sensory Analysis Laboratory of the University of Life Sciences Iasi, a space equipped with boards to separate the evaluators so that individual perception could not be influenced. Each assessor was provided with plain water and unsalted biscuits to rinse the palate after each assessed sample.

The samples were prepared in a separate room, coded, placed on plates and presented to the assessors in blind so that only the organiser of the assessment knew the identity of each sample.

The results obtained from the sensory evaluation questionnaire were collected and statistically processed with the Data Analysis function of Excel software using the two-way ANOVA test.

Analysis of variance (ANOVA) was used to determine the presence of a statistically significant difference between the mean scores of the six samples, according to the two differentiating factors (quantities of ingredients introduced into the brine and levels of brine injected).

RESULTS AND DISCUSSIONS

The colour of the six beef pastrami samples was assessed by the panellists in terms of intensity and uniformity. On the 9-point scale, the samples with the highest mean scores for colour intensity were A_1 and B_1 (Table 1), the percentage of brine introduced showing distinctly significant differences ($P < 0.01$) between experimental batches. The ingredients added to the brine solution significantly ($P < 0.05$) influenced the perception of colour intensity of the evaluated samples.

Table 1. Sensory evaluation of color of beef pastrami as influenced by the salting solution and the injection proportions

	Attributes	n	Batch no.						Effect		
			Batch A			Batch B			F1	F2	F1 x F2
			A_1	A_2	A_3	B_1	B_2	B_3			
COLOUR	Colour intensity	24	8.5 ±0.34	8.04 ±0.65	7.50 ±0.43	8.75 ±0.19	8.25 ±0.45	7.70 ±0.38	1.18E-11**	0.039*	0.983 ^{ns}
	Colour uniformity		7.33 ±0.89	7.41 ±0.68	6.66 ±0.92	7.58 ±0.31	7.45 ±0.34	6.33 ±0.21	9.5E-06**	0.936^{ns}	0.296 ^{ns}

n = number of evaluations per sample; ±SD = standard deviation; F1 = percentage of brine injected; F2 = proportions of ingredients added to the brine; F1 x F2 = the effect of the interaction of the two factors; ns = $P > 0.05$; * = $P < 0.05$; ** = $P < 0.01$.

As for the colour uniformity of the six batches, significant differences ($P < 0.01$) were observed due to the change in the volume of solution injected, but the amounts of ingredients added to the brine and the interaction between the two factors did not generate significant changes between the batches ($P > 0.05$). However, a higher uniformity was observed for batches that were injected with 10% brine, meaning that at this injection level the brine was evenly distributed throughout the mass of the product.

The results of the sensory aroma evaluation of the experimental batches are shown in Table 2. The overall aroma intensity of the six samples was scored with mean scores ranging from a minimum of 5.87±0.63 (for batch A_3) to a maximum of 6.62±0.41 (for batch B_2). Overall aroma intensity was mainly influenced by the level of brine introduced in the experimental batches ($P < 0.01$).

The metallic flavour was identified as more intense in the samples with the lowest percentage of brine introduced, thus this factor had a significant influence ($P < 0.01$) on the perception of the evaluators. The pungent, rapeseed oil-specific and grassy aroma had mean scores directly and significantly ($P < 0.01$, $P > 0.05$) influenced by the percentage of brine injected and the proportions of ingredients introduced in the brine solution. An inversely proportional relationship was observed between meat-specific metallic flavour and pungent flavour and alfalfa flavour specific to the ingredients added to the solution. Thus, sample

3 from batch B showed the lowest mean score for metallic flavour (1.33±0.23) and the highest scores for pungent flavour (1.83±0.75) and alfalfa flavour (2.04±0.65).

For rancid flavour, all samples of the experimental batches received subunit mean scores, with distinctly significant differences (P < 0.01) due to different percentages of brine, and significant differences (P > 0.05) due to different amounts of ingredients introduced into the brine solution.

Table 2. Sensory aroma of beef pastrami as influenced by the salting solution and the injection proportions

	Attributes	n	Batch no. Batch A A_1	A_2	A_3	Batch B B_1	B_2	B_3	Effect F1	F2	F1 x F2
AROMA	Overall intensity	24	6.04 ±0.65	6.37 ±0.41	5.87 ±0.63	6.25 ±0.45	6.62 ±0.41	6.08 ±0.60	0.002**	0.069 ns	0.986 ns
	Metallic aroma		2.62 ±0.24	1.75 ±0.28	1.37 ±0.24	2.50 ±0.43	1.66 ±0.31	1.33 ±0.23	3.21E-20**	0.357 ns	0.931 ns
	Pungent aroma		0.79 ±0.43	1.29 ±0.30	1.58 ±0.25	0.83 ±0.40	1.62 ±0.24	1.83 ±0.75	3.22E-10**	0.049*	0.508 ns
	Grassy aroma		1.00 ±0.52	1.33 ±0.40	1.83 ±0.31	1.12 ±0.46	1.75 ±0.36	2.04 ±0.65	1.92E-08**	0.027*	0.552 ns
	Rancid aroma		0.20 ±0.17	0.62 ±0.41	0.54 ±0.78	0.37 ±0.24	0.83 ±0.66	0.95 ±0.73	0.002**	0.027*	0.652 ns

n = number of evaluations per sample; ±SD = standard deviation; F1 = percentage of brine injected; F2 = proportions of ingredients added to the brine; F1 x F2 = the effect of the interaction of the two factors; ns = P > 0.05; * = P < 0.05; ** = P < 0.01.

In terms of texture, the attributes assessed were hardness, tenderness, elasticity and juiciness, the average scores obtained are shown in Table 3. The level of injection influenced the perception of all texture attributes evaluated to the greatest extent (P < 0.01), whereas the ingredients, added to the brine in different proportions influenced significantly only the juiciness of the samples (P < 0.01).

Table 3. Sensory evaluation of texture of beef pastrami as influenced by the salting solution and the injection proportions

	Attributes	n	Batch no. Batch A A_1	A_2	A_3	Batch B B_1	B_2	B_3	Effect F1	F2	F1 x F2
TEXTURE	Hardness	24	2.54 ±0.43	1.66 ±0.40	1.29 ±0.56	2.83 ±0.57	2.20 ±0.43	1.16 ±0.75	1.22E-16**	0.053 ns	0.079 ns
	Tenderness		5.04 ±0.56	6.04 ±0.30	6.79 ±0.43	4.91 ±0.60	5.75 ±0.63	6.54 ±0.86	1E-19**	0.078 ns	0.852 ns
	Elasticity		2.58 ±0.34	2.70 ±0.84	3.62 ±1.28	2.66 ±0.31	3.66 ±0.84	3.00 ±0.52	3E-08**	0.322 ns	0.736 ns
	Juiciness		4.95 ±0.56	5.62 ±0.41	6.41 ±0.42	4.64 ±0.41	5.20 ±0.60	6.16 ±0.66	1E-17**	0.006**	0.851 ns

n = number of evaluations per sample; ±SD = standard deviation; F1 = percentage of brine injected; F2 = proportions of ingredients added to the brine; F1 x F2 = the effect of the interaction of the two factors; ns = P > 0.05; * = P < 0.05; ** = P < 0.01.

The freshness of the batches after heat treatment increased significantly (P < 0.01) with increasing levels of introduced brine. These results are similar to those obtained by Boles and Shand

(2001) who studied how anatomical region and injection percentage influence the tenderness and cooking yield of beef. Moreover, as the amount of brine introduced increased, the amount of water in the product also increased. This may explain the higher average scores given by the evaluators to the juiciness attribute for samples with a higher percentage of salting solution introduced.

The elasticity of the experimental samples was significantly influenced by the percentage of brine injected ($P < 0.01$). The samples with the highest elasticity were A_3 (with 30% brine injected) for the first experimental batch and B_2 (with 20% brine injected) for the second experimental batch, with mean scores of 3.62±1.28 and 3.66±0.84.

The taste of the experimental batches was evaluated in terms of salty, sour, bitter and umami tastes. The percentage of brine introduced significantly ($P < 0.01$) influenced the perception of salty taste. Although the two brine solutions had different amounts of salt, no significant differences ($P > 0.05$) were found between batches due to this variable. In contrast to the results obtained by McDonald et al. (2001), where increasing the injection level led to a decrease in the intensity of the salty taste, in the present study the salty taste was perceived as more intense the higher the injection percentage. Therefore, the salty taste was identified by the evaluators with higher mean scores in samples A_3 and B_3, those where the injection percentage was 30%.

Sour taste can be associated with the pungent flavour identified as the two attributes obtained similar mean scores, with the factor of different ingredient ratios showing distinctly significant differences between experimental batches ($P < 0.01$).

Bitter taste and umami were very poorly identified by the evaluators in the samples under analysis, obtaining the lowest mean scores ranging from 0.29±0.21 (A_1) to 1.20±0.69 (B_3) for bitter taste and from 0.87±0.54 (A_1) to 1.41±0.60 (B_2) for umami taste (Table 4).

Table 4. Sensory evaluation of taste for beef pastrami as influenced by the salting solution and the injection proportions

	Attributes	n	Batch no.						Effect		
			Batch A			Batch B			F1	F2	F1 x F2
			A_1	A_2	A_3	B_1	B_2	B_3			
TASTE	Salty	24	2.37 ±0.24	3.12 ±0.63	3.45 ±1.12	2.62 ±0.50	3.37 ±1.28	3.58 ±1.07	1.84E-06**	0.19 ns	0.934 ns
	Sour		1.04 ±0.30	1.16 ±0.23	1.33 ±0.57	1.87 ±0.37	1.83 ±0.14	1.91 ±0.34	0.336 ns	2.52E-11**	0.555 ns
	Bitter		0.29 ±0.21	0.91 ±0.42	0.75 ±0.71	0.58 ±0.34	1.00 ±0.60	1.20 ±0.69	0.0002**	0.019*	0.431 ns
	Umami		0.87 ±0.54	1.08 ±0.68	1.00 ±0.60	1.29 ±0.56	1.41 ±0.60	1.04 ±0.56	0.175 ns	0.042*	0.859 ns

n = number of evaluations per sample; ±SD = standard deviation; F1 = percentage of brine injected; F2 = proportions of ingredients added to the brine; F1 x F2 = the effect of the interaction of the two factors; ns = $P > 0.05$; * = $P < 0.05$; ** = $P < 0.01$.

CONCLUSIONS

Based on the results obtained from the sensory evaluation of the six experimental batches of beef pastrami, it was found that the colour characteristics were significantly influenced by the percentage of brine injected into the meat ($P < 0.01$). The highest mean values for colour intensity and uniformity were recorded for the samples injected with the lowest percentage of brine (10%). Aroma attributes were also significantly affected by increasing the amount of brine ($P < 0.01$). By the additions used in the brine solution (rapeseed oil and lucerne powder), specific flavours (pungent aroma, grassy aroma) were identified in the products obtained, whose intensity was significantly influenced by the two variation factors ($P < 0.01$). The texture of the experimental batches was significantly influenced ($P < 0.01$) by the amount of brine injected into the meat, samples injected with 30% brine solution showed higher tenderness and juiciness compared to those injected with lower percentages of brine. In addition, juiciness was higher in batch A, possibly due to the lower oil and alfalfa powder content of the brine, which facilitated diffusion of the solution into the product mass. The most intense taste identified by the evaluators was salty, significantly influenced ($P < 0.01$) by the percentage of brine in the product; while sour, bitter and umami tastes were poorly identified in the experimental batches.

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