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Original scientific paper

Effects of different cooking methods of pork and beef on textural properties and sensory quality

Sara Simunović[a,b], Igor Tomasević[c,d], Vesna Đorđević[a], Tatjana Baltić[a], Jelena Ćirić[a], Stefan Simunović[a] and Ilija Đekić[b]

[a] Institute of Meat Hygiene and Technology, Kaćanskog 13, 11040, Belgrade, Serbia
[b] University of Belgrade, Faculty of Agriculture, Department of Food Safety and Quality Management, Belgrade, Nemanjina 6, 11080 Belgrade, Serbia
[c] Department of Animal Source Food Technology, Faculty of Agriculture, University of Belgrade, Nemanjina 6, 11080 Belgrade, Serbia
[d] German Institute of Food Technologies (DIL), Quakenbruck, Germany

A R T I C L E I N F O

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A B S T R A C T

This study investigates the effects of different cooking methods and meat cuts on the textural and sensory properties of pork and beef. Meat samples were prepared according to guidelines and relevant standards using pan frying and grilling. Three types of pork cuts were included (pork ham, loin and neck) and three types of beef steak (chuck steak, round steak and sirloin steak). Textural properties such as hardness, springiness, cohesiveness, gumminess, and chewiness were analyzed. Sensory attributes that are the most common for assessing the palatability of cooked meat were used. In the comparison of cooking methods within textural parameters, grilled pork and beef samples were tougher than fried ones. The cooking methods of meat samples depending on types of cuts resulted in different sensory attributes.

1. Introduction

In Serbia from the data for 2023, the import of raw meat is increasing, especially when it comes to pork. The main reasons for that are declines in pork prices on the one hand, and on the other hand, increases in prices of all inputs required for farming. However, the availability for Serbian consumers of pork is at an acceptable level, with 90% of pork available to consumers being locally produced (*RZS*, 2023a).

The systematic changes and strategies are necessary for meat producers and farmers, in order to continue to produce meat continually and in a socially responsible manner. Regardless of the phase in the meat chain, all stakeholders from the livestock and feed production to retailers and consumers, need to be aware of possible price increases of meat. Recent governmental reports predicted 20% of meat price increase. However, meat is the second largest food category in Serbia that affects the average annual increase of food prices, accounting for approximately 23.9% of the total increase of food prices (*RZS*, 2023b). In this share, beef has the largest impact on food price increasing, while pork and chicken follow.

Meat production is mainly focused on the technological, environmental, ethical, nutritional and healthy aspects of meat and meat products (*Djekic et al*., 2016; *Grunert et al*., 2018). However, when observing any of these approaches, their impact on the quality of

***Corresponding author:** Sara Simunović, sara.rajic@inmes.rs

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meat and meat products should be considered, as well as the changes in sensory and textural features (*Simunovic et al.*, 2020). In this case, additional quality controls are required for implementing new quality tools for monitoring. These changes and improvements are acquiring more human and financial resources, and consequently greater consumer satisfaction.

The objective of this research is to evaluate the effects of different thermic treatments and types of muscles on textural properties and sensory quality of meat. Previous studies showed influences of visual marbling score, carcass weight, cooking methods, aging technologies, etc. on the sensory quality and consumer's acceptance of fresh meat (*Cannata et al.*, 2010; *Gurinovich et al.*, 2023; *Hwang et al.*, 2019; *Hwang et al.*, 2020). To our knowledge, there are a limited number of studies that have examined the effect of cooking methods on fresh meat quality, especially beef (*Grujić et al.*, 2014; *Wołoszyn et al.*, 2020).

2. Materials and methods

2.1. Pork and beef samples

For the purpose of this research, three types of pork cuts (pork ham, loin and neck) and three types of beef steak (chuck steak, round steak and sirloin steak) were used. The samples were purchased locally at retail in Belgrade. After purchase, pork and beef were cut in uniform steaks, sealed in vacuum bags and stored in the refrigerator at 2 to 5°C. Before cooking, steaks were placed at room temperature for half an hour.

2.2. Cooking methods

Two cooking methods were used: pan frying and grilling. Pan frying is using a pan with additional oil placed on the direct heat of a conduction cook-top. On the other hand, treatment by open-heat electric grill is a popular method of cooking that has largely replaced others. A grill with a lid that closed on the meat and heated from top and bottom was used.

In both cases the heating procedure was the same, according to American Meat Science Association guidelines (*AMSA*, 2016). Firstly, appliances were preheated for at least 10 minutes. During that time, meat sample weights before cooking were recorded. Meat samples were placed on the pan and electric grill surfaces and removed when samples reached the desired internal temperature (71°C for all cuts of pork and beef).

Meat samples were cooled to room temperature, and prior to serving were sliced into cubes. The *AMSA* (2016) recommendations were used to achieve an appropriate and uniform thickness and size of samples. The final size of all samples for sensory analysis was 25.4 mm x 25.4 mm x 25.4 mm.

2.3. Instrumental texture analysis

Texture profile analysis (TPA) was performed using TA.XT Plus Texture Analyzer (Stable Micro Systems Ltd., Vienna Court, UK) according to *Simunovic et al*. (2020) with some modifications. Uniform size cuts (approximate mass of 230 g) were prepared for each type of cut for pork and beef and both cooking methods. Rectangular samples (20 mm height, 15 × 15 mm base) were cut off along the axis of the muscle fibers and used for testing. Nine samples of pork and nine samples of beef from each type of cuts were measured, 54 per cooking method in total (2 x 9 x 3).

2.4. Sensory evaluation

2.4.1. Descriptive sensory analysis

The descriptive analysis was done by trained sensory panel in the Laboratory for Sensory Testing at the Institute of Meat Hygiene and Technology. The sensory panel consisted of 10 panelists (four male and six female members) experienced in sensory evaluation and of a good general health condition (*Djekic et al.*, 2021). Eight-point scales were used for evaluating tenderness, juiciness, and flavor intensity (*AMSA*, 2016). The points of scales were from 1 – extremely tough to 8 – extremely tender for tenderness, 1 – extremely dry to 8 – extremely juicy for juiciness, and 1 – none to 8 – extremely intense for flavor intensity.

2.4.2. Triangle test

The sensory panel consisted of 36 untrained panelists (consumers). They tested samples in laboratory conditions at the University of Belgrade, Faculty of Agriculture. Testing was carried out under conditions that prevented communication among assessors until all the evaluations had been completed. The panelists were informed that two samples were the same and that one was different. For the purpose of triangle test, grilled pork ham and pork loin were used, as these had been chosen as the best scored samples during descriptive analysis. The selection of beef samples followed the same procedure; thus, grilled beef round steaks and sirloin steaks were included in triangle test.

2.4.3. Statistical analysis

In order to analyze results of textural properties and sensory analysis, descriptive statistics, testing of normal distribution (Shapiro–Wilk), homogeneity of variances (Levene Statistic), one-way analysis of variance (ANOVA), and post hoc test (Tukey) were performed using SPSS package (SPSS 23.0, Chicago, IL, USA).

3. Results and discussion

3.1. Influence on textural properties

According to Table 1, the hardness was not significantly different among all samples of cooked pork. However, grilled pork cuts were tougher, among which pork ham had the highest hardness value. This was also investigated by *Djekic et al.* (2021), where the high impact of culinary methods on both quality and oral processing parameters of pork ham was confirmed. On the other hand, grilled samples showed significant difference of cohesiveness, gumminess, and chewiness, among which pork ham and neck had the highest values ($p < 0.05$). Values for springiness were not significantly different in both cooking methods.

Contrary to pork samples, the hardness was significantly different for all beef cuts ($p < 0.05$; Table 2). Generally, grilled beef samples were tougher than fried ones. The tenderest beef cut was fried chuck steak, while the toughest one was grilled sirloin steak. Furthermore, gumminess was significantly different within fried and grilled beef samples. Similar to hardness, values of gumminess were the lowest for fried chuck steak, while the highest values were for sirloin steak. Chewiness was significantly different only for grilled beef samples, which is similar to pork results. On the other hand, values for springiness and cohesiveness were not significantly different.

Values (mean ± standard deviation) with different lowercase letters (a-c) in the same row differ significantly ($p < 0.05$).

Table 1. Textural properties of pork with different cooking methods

	Pan frying			Grilling		
Attributes	**Ham**	**Loin**	**Neck**	**Ham**	**Loin**	**Neck**
Hardness (N)	9.08 ± 3.33	13.31 ± 10.57	8.69 ± 2.12	17.92 ± 5.32	14.36 ± 2.69	17.61 ± 4.21
Springiness	0.72 ± 0.05	0.72 ± 0.08	0.72 ± 0.10	0.75 ± 0.07	0.69 ± 0.03	0.73 ± 0.09
Cohesiveness	0.67 ± 0.06	0.65 ± 0.06	0.67 ± 0.17	0.67 ± 0.04 ^{a}	0.60 ± 0.03 ^{b}	0.68 ± 0.05 ^{c}
Gumminess (N)	6.25 ± 2.34	8.21 ± 5.87	5.71 ± 2.05	12.78 ± 3.53 ^{a}	8.59 ± 1.52 ^{b}	13.75 ± 3.83 ^{c}
Chewiness (N)	4.57 ± 1.75	5.71 ± 3.88	5.8 ± 2.18	9.52 ± 2.69 ^{a}	5.96 ± 1.06 ^{b}	9.75 ± 2.20 ^{c}

Values (mean ± standard deviation) with different lowercase letters (a-c) in the same row differ significantly ($p < 0.05$).

Table 2. Textural properties of beef with different cooking methods

	Pan frying			Grilling		
Attributes	**Chuck steak**	**Round steak**	**Sirloin steak**	**Chuck steak**	**Round steak**	**Sirloin steak**
Hardness (N)	9.2 ± 6.47^{a}	16.03 ± 6.96^{b}	18.76 ± 10.5^{c}	22.13 ± 5.75^{a}	13.28 ± 5.33^{b}	30.81 ± 8.75^{c}
Springiness	0.66 ± 0.08	0.65 ± 0.08	0.69 ± 0.27	0.68 ± 0.03	0.62 ± 0.24	0.66 ± 0.11
Cohesiveness	0.59 ± 0.01	0.63 ± 0.05	0.67 ± 0.06	0.6 ± 0.06	0.55 ± 0.21	0.59 ± 0.03
Gumminess (N)	5.86 ± 4.68^{a}	10.89 ± 4.34^{b}	12.85 ± 8.3^{c}	13.47 ± 4.17^{a}	7.72 ± 4.33^{b}	18.56 ± 1.73^{c}
Chewiness (N)	3.73 ± 3.14	6.35 ± 2.58	5.57 ± 2.79	9.25 ± 3.02^{a}	5.42 ± 3.16^{b}	12.95 ± 9.2^{4c}

Values (mean ± standard deviation) with different lowercase letters (a-c) in the same row differ significantly ($p < 0.05$).

3.2. Influence on sensory quality

Firstly, the tenderness was not significantly different within both groups of cooked pork samples. This means the sensory panel was consistent in their responses. The lowest mean value for tenderness was evaluated for pork ham (Table 3), which means the sensory panel evaluated pork ham as the toughest sample. On the other hand, pork ham was scored as juicier than pork neck by the sensory panel.

However, juiciness of all treated pork samples was found to be significantly different within both cooking methods ($p < 0.05$). The pork loin was evaluated with the highest scores for all examined sensory attributes: tenderness, juiciness, and flavor in both cooking methods. That means pork loin had the best-scored sensory quality. On the other hand, pork ham and neck were scored similarly in general.

When it comes to flavor, the scores of fried pork samples were found to be significantly different ($p < 0.05$; Table 3). This is in accordance with the findings of *Peñaranda et al.* (2017) where it was revealed that fried pork meat had the highest intensity of flavor in comparison with grilled samples.

In the case of beef (Table 4), only tenderness was found to be significantly different ($p < 0.05$) and just within fried samples. The tenderness values of fried beef steaks were influenced by the cut, which was also confirmed in study of *Miller et al.* (2023). Round steak was evaluated as the most tender cooked sample. When it comes to juiciness and flavor, grilled sirloin steak was evaluated as the juiciest and the most characteristic in flavor. This was also confirmed by the study of (*Liu et al.,* 2020) where the premium beef steaks had the best scores for each sensory trait.

On the other hand, chuck steaks had the lowest scores for all sensory attributes, which is in accordance with results of *Miller et al.* (2022), where consumers rated chuck roasts lowest for overall, overall flavor, grilled flavor, and juiciness liking.

The objective of the triangle test was to analyze whether two samples are different. According to standard ISO 4120 (*ISO*, 2021), the following parameters were selected: $\alpha = 0.05$ (probability of concluding that a perceptible difference exists when one does not), $\beta = 0.05$ (probability of concluding that no perceptible difference exists when one does) and $p_d = 50\%$ (50% of assessors can detect difference). A total of 36 panelists were selected for both triangle tests. For pork meat, 14 panelists correctly identified the odd sample leading to the conclusion that pork samples were not perceived as different. On the contrary for beef, 20 assessors correctly

Table 3. Sensory evaluation of pork with different cooking methods

	Pan frying			Grilling		
Sensory Attributes	**Ham**	**Loin**	**Neck**	**Ham**	**Loin**	**Neck**
Tenderness	5.85 ± 1.36	6.25 ± 1.74	6.25 ± 1.74	6.03 ± 1.42	6.80 ± 1.61	6.15 ± 1.66
Juiciness	5.15 ± 1.66[a]	6.90 ± 0.77[b]	5.15 ± 1.57[c]	6.18 ± 1.42[a]	7.00 ± 1.37[b]	5.58 ± 1.59[c]
Flavor Intensity	6.18 ± 1.37[a]	7.00 ± 1.37[b]	5.58 ± 1.59c	6.30 ± 1.08	7.18 ± 1.15	6.35 ± 1.49

Values (mean ± standard deviation) with different lowercase letters (a-c) in the same row differ significantly ($p < 0.05$). Scale: "1 – extremely tough to 8 – extremely tender"; "1 – extremely dry to 8 – extremely juicy"; "1 – none to 8 – extremely intense".

Table 4. Sensory evaluation of beef with different cooking methods

	Pan frying			Grilling		
Sensory Attributes	**Chuck steak**	**Round steak**	**Sirloin steak**	**Chuck steak**	**Round steak**	**Sirloin steak**
Tenderness	4.05 ± 1.51[a]	5.23 ± 1.33[b]	4.13 ± 1.45[c]	4.33 ± 1.44	5.40 ± 1.49	4.73 ± 1.81
Juiciness	4.85 ± 1.73	5.30 ± 1.35	4.93 ± 1.52	4.98 ± 1.37	5.10 ± 1.34	5.49 ± 1.34
Flavor Intensity	5.37 ± 1.37	5.45 ± 1.44	5.47 ± 1.41	5.38 ± 1.2	5.43 ± 1.44	5.53 ± 1.51

Values (mean ± standard deviation) with different lowercase letters (a-c) in the same row differ significantly ($p < 0.05$). Scale: "1 – extremely tough to 8 – extremely tender"; "1 – extremely dry to 8 – extremely juicy"; "1 – none to 8 – extremely intense".

identified the odd sample, and this number was sufficient to conclude that the two beef samples were perceptibly different.

4. Conclusion

Results from this study regarding texture analyses indicate that cooking methods had impact on texture of meat, so more precisely, grilling makes pork and beef samples tougher than pan frying. Furthermore, hardness and gumminess values of beef samples are significantly different when comparing pan frying and grilling. Moreover, cooking methods influence the sensory quality of meat, especially when it comes to juiciness of pan-fried and grilled pork samples. Beside cooking methods, the influence of types of meat cuts was noted, identifying the toughest meat samples — pork ham and beef sirloin steak. Likewise, the sensory quality of pork and beef was influenced by the type of meat cut. The flavor intensity scores for different cuts of fried pork were significantly different. When it comes to different types of fried beef steaks, values of tenderness were significantly different across samples.

A limitation of the study may be the absence of consumer preference analysis related to pork and beef prepared with the more than two cooking methods. Future research into pork and beef could investigate influences of other cooking methods and/or other types of meat cuts.

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