IMPROVING MEAT TENDERNESS USING EXOGENOUS PROCESSES: INSIGHT OF METHOD'S EFFECTIVENESS

Rosaria Marino*, Antonella della Malva, Mariangela Caroprese, Teresa De Pilli, Agostino Sevi and Marzia Albenzio

Department of Agriculture, Food, Natural Resources and Engineering , University of Foggia, Italy

*Corresponding author email: rosaria.marino@unifg.it

I. INTRODUCTION

Post-mortem aging is one of the most important meat processes for obtaining a satisfactory increase of meat tenderness due to the action of endogenous enzymes on myofibrillar proteins. However, in cuts (e.g. from *semitendinosus* muscle) with high amount of connective tissue this method is inadequate, since negligible degradation occurs for collagen [1]. In the last years, several promising methods have been investigated in order to achieve an adequate level of tenderness reducing costs, time and its variability among different commercial cuts. Particularly papain is one of the main plant proteases used to tenderize artificially meat due to its ability to break down both myofibrillar proteins and connective tissue. Previous study highlighted that the combination with ultrasound technology is an useful mean to achieve enhanced enzyme diffusion in meat [2]. Although it has been documented that consumers are cautious about accepting new technologies applied to meat sector because of perceived risk [3].Therefore the present research aims to evaluate the effects of papain and ultrasound treatments, applied individually or in combination, on the textural and sensory properties of *semitendinosus* muscle.

II. MATERIALS AND METHODS

Eight *Semitendinosus* muscles) were collected from 8 male beef cattle, each muscle was divided into ten uniform slices and all slices were randomly allocated into 5 experimental groups as follows: Papain injection (PI): 100 TU/mg of papain dissolved into 100 mL of phosphate buffer pH 6.0 was injected uniformly into each meat samples using a multi needle syringe; Ultrasound (US): meat samples were exposed to ultrasonic waves using a probe at an operating frequency of 40 kHz with a constant amplitude of 100%; Papain injection followed by ultrasound (PIUS): meat samples were exposed first to injection of papain solution and subsequently to ultrasound; Ultrasound followed by papain injection (USPI): meat samples were exposed first to US treatment and after to injection of papain; Control (C): meat samples–aged at 3 °C were considered as control. For each treatment, eight slices were analyzed after 2 h, while the remaining samples were vacuum packaged and stored at 3 ◦C for 96 h. MFI, Warner Bratzler shear force (WBSF) and texture profile analysis (TPA) were estimated [2]. The sensory properties was evaluated on steaks grilled to an internal temperature of 75°C by a panel of 10 assessors, previously trained to develop a commune sensory vocabulary and to evaluate the intensity of attributes (colour, taste, flavour, tenderness, juiciness, chewiness, appearance, total acceptability). Attributes were rated on the basis of 100 mm unstructured lines with anchor points at each end (0: absent and 100: very strong). All data was analyzed using the GLM procedure of the SAS statistical software.

III. RESULTS AND DISCUSSION

MFI, WBSF and texture profile parameters were affected by tenderization treatments and storage time, as shown in table 1. Passing from 2 to 96 hours of storage higher increase of myofibrillar fragmentation index in samples treated with papain alone or coupled with ultrasound was observed compared to US and C samples. Meat treated with papain alone or combined with ultrasound showed lower WBSF and hardness values than C and US samples. Particularly, meat treated with PI showed lower value than combined methods at 2h, while, after 96 hours of storage meat from USPI treatment showed WBSF value comparable to PI treatment.

Table 1. pH and myfibrillar fragmentation index (MFI) of semitendinosus muscle as affected by tenderization treatments (C= control; PI= papain injection; US= ultrasound; PIUS= papain injection followed by ultrasound; USPI= ultrasound followed by papain injection) and storage time (means ± SEM)

		Tenderization treatments						Effects, P	
	storage (h)	C	US	PI	PIUS	USPI	SEM	Treatment	Storage
MFI	*2*	26.2 ^{C}	29.3 ^{D}	35.6 ^{D}	34.3 ^{D}	33.7 ^{D}	4.53	0.001	0.02
	96	87.5 ^{cA}	107 ^{bA}	139 ^{aA}	133 ^{aA}	138 ^{aA}			
WBSF (N)	*2*	57.8 ^{a}	46.2 ^{b}	34.3 ^{d}	41.2 ^{cA}	40.9 ^{cA}	0.92	0.001	0.01
	96	54.5 ^{a}	44.9 ^{b}	32.8 ^{d}	36.2 ^{cB}	33.5 ^{dC}			
Hardness (N)	*2*	57.6 ^{a}	49.8 ^{b}	41.5 ^{c}	43.5 ^{cA}	43.2 ^{cA}	0.71	0.001	0.01
	96	56.2 ^{a}	46.3 ^{b}	40.8 ^{c}	41.1 ^{cB}	40.9 ^{cB}			
Cohesiveness	*2*	0.20 ^{a}	0.19 ^{a}	0.13 ^{b}	0.18 ^{ab}	0.18 ^{ab}	0.02	0.001	0.25
	96	0.18 ^{a}	0.18 ^{a}	0.11 ^{b}	0.16 ^{ab}	0.16 ^{ab}			
Gumminess (N)	*2*	11.8 ^{a}	9.50 ^{b}	5.41 ^{d}	7.81 ^{c}	7.82 ^{c}	0.76	0.001	0.14
	96	10.1 ^{a}	8.31 ^{b}	4.50 ^{d}	6.60 ^{c}	6.51 ^{c}			
Chewiness (N x mm)	*2*	91.0 ^{aA}	74.9 ^{bA}	42.4 ^{dA}	60.5 ^{cA}	59.8 ^{cA}	1.52	0.001	0.01
	96	80.2 ^{aB}	65.8 ^{bB}	35.4 ^{dB}	52.3 ^{cB}	51.1 ^{cB}			

$^{a, b, c}$= P< 0.05 in the row (treatment effect). $^{A, B, C}$ = P<0.05 in the column (storage effect).

The lowest values of cohesiveness and of gumminess and chewiness were found in meat from PI treatment. Tenderization treatments affected several sensory profile attributes (data not shown). At 2h, tenderness and chewiness were greater in meat treated with papain than control (P<0.001), better taste was found in meat from USEI compared to EI and control (P<0.05). Appearance and total acceptability showed higher score in meat from control and USEI compared to EI (P<0.01), while the highest and the lowest scores for colour parameter (P<0.01) were assigned to the meat of the control and EI treatments, respectively. After 96 h differences tenderization treatment did not affected colour parameter and an improvement for taste (P<0.01), and tenderness (P<0.01), were found in EI and USEI samples, respectively. This data highlight that papain injection promotes intense proteolysis that led to a strong and early tenderization process with a reduced stability and integrity of microstructure as suggested by the lower scores received for appearance and total acceptability in PI samples.

IV. CONCLUSION

Our results suggest that ultrasound applied before papain treatment was able to modulate tenderization rate reaching the same in improvement in tenderness of papain treatment at the end of storage time, but with slower hydrolysing rate. This behaviour could be determinant in preserving the meat structure in term of chewiness and myofibrillar proteins degradation.

REFERENCES

1. Purslow, P. P. (2018). Contribution of collagen and connective tissue to cooked meat toughness; some paradigms reviewed. Meat Science 144: 127–134.
2. Marino, R., della Malva, A., Caroprese, M., De Pilli, T., Alessandrino, O., Picariello, G., Sevi, A. & Albenzio M. (2023). Proteomics in bovine *semitendinosus* muscle to assess emerging strategies based on papain injection and ultrasounds on meat tenderization process. Meat Science 200: 109147.
3. De Devitiis, B., Viscecchia, R., Seccia, A., Nardone, G., Carlucci, D., Albenzio, M., Sevi, A . & Marino, R. (2023). Improving meat tenderness using exogenous process: the consumer response. Meat Science 200:109164.