INFLUENCE OF SONICATION ON BEEF AGEING

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Introduction

Formation of technological properties of meat is a complicated, yet very important stage of its processing. Meat quality is assessed from the point of view of its technological and culinary properties. One of the most important features during technological evaluation of meat is its tenderness. Meat tenderness is highly affected by *post mortem* changes of myofibrills. Rigor onset followed by degradation of myofibrills structure affects water holding capacity (WHC), cooking loss and consequently production of meat of desirable tenderness. Attempts have been made to apply ultrasound waves during meat ageing, especially for beef. Interest in ultrasound applications is connected with the effects of its use on biological materials (Got et al., 1999; Mason et al., 1996; McClements, 1995; Pohlman et al., 1997; Twarda and Dolatowski, 2006). Muscle tissue is a special area for ultrasound propagation. Results of previous research show that ultrasound treatment has an influence on meat ageing, especially on myofibrillar proteins (Dolatowski and Twarda, 2004; Lyng et al.,1997).

The aim of research was to investigate the influence of ultrasound treatment on technological properties of beef.

Materials and Methods

Investigations were carried out on young bulls (Lowland Black and White breed) slaughtered at a live weight of approximately 450 - 500 kg following standard procedure. The muscles (*m. semimembranosus*), free from quality defects, were excised at 24 hour post mortem from left half - carcasses of temperature 7°C. Muscle, free of external fat and connective tissue, was divided into eight blocks, (70 mm x 70 mm x 80 mm, length, width and height, respectively) of about 400 g. Four of the parts were regarded as control samples (C). The other four were subjected to ultrasound treatment with frequency of 45 kHz (sample U). In order to carry out ultrasound treatment samples packed in polyethylene bags were placed into an ultrasound bath (Polsonic, Warsaw, Poland) filled with cold water (4°C) and then sonicated. The low intensity ultrasonic field (2 W/cm^2) was applied perpendicularly to muscle fibers for 120 s. Meat samples were then stored at 4°C until assessed. Directly after ultrasound treatment and then daily for a total of 4 days the following characteristics were tested: acidity, water holding capacity (Wierbicki et al., 1962), lightness L^* (X - Rite 8200), free calcium ions concentration by ASA method (Geesink et al., 2001), shear force (TA-XT plus; Stable Micro Systems) as well as myofibrillar fragmentation index MFI (Møller et al., 1973).

Three series of experiments and three replications of each experiment were conducted. Obtained results were subjected to statistical analysis (α=0.05).

Results and Discussion

Based on the statistical analysis of obtained results, it was found that there were no significant differences between acidity values of both samples directly after sonication as well as after 72 and 96 hours of storage.

Directly after ultrasound treatment differences in water holding capacity between examined samples were not significant (tab. 1). Statistically significant decrease of water holding capacity was observed 48 hours after slaughter. After 72 hours of ageing sample U - subjected to ultrasound treatment, was having almost two times higher water holding capacity (11.13%) than the control sample (5.05%). Experiments carried out 96 hours after slaughter proved further increase of water holding capacity.

Table 1. Influence of ultrasound treatment on acidity, water holding capacity and lightness of meat (mean ± standard error)

Sample	Parameter	Time after slaughter (hours)			
		24	48	72	96
C	pH	5.56±0.02^a	5.42±0.02^b	5.47±0.02^d	5.57±0.02^e
U		5.58±0.03^a	5.48±0.01^c	5.51±0.03^d	5.55±0.04^e
C	WHC	5.88±0.86^a	-8.85±0.41^b	5.05±0.13^d	6.66±0.58^f
U	(%)	4.59±0.09^a	-4.49±0.29^c	11.13±0.38^e	17.20±1.52^g
C	L^*	40.07±0.72^a	39.41±1.01^c	38.70±3.68^d	37.26±1.36^e
U		41.90±2.99^b	38.32±1.64^c	39.67±2.17^d	38.47±1.45^e

Means followed by the same letters $^{a-g}$ do not differ significantly (α = 0.05)

During the whole period of ageing examined meat samples were characterized by similar lightness (tab. 1). Significant differences in L^* values were noted only directly after ultrasound treatment. At that time meat subjected to sonication was having higher L^* values than the control sample.

The control sample was having significantly higher shear force than the U sample 48 and 72 hours after slaughter (tab. 2). The passage of time was coupled with a decrease of this parameter for both samples.

During measurements carried out 24 and 72 hours after slaughter significantly lower MFI index values were obtained for the U sample. Passage of time after slaughter was coupled with an increase of MFI for both samples.

Free calcium ions concentration was increasing during the ageing period. For U sample higher concentration of free Ca^{2+} was recorded at every stage of the experiment. The differences between samples were significant 72 and 96 hours after slaughter.

Table 2. Influence of ultrasound treatment on shear force, MFI and free calcium ions concentration (mean ± standard error)

Sample	Parameter	Time after slaughter (hours)			
		24	48	72	96
C	Shear force (N)	39.60 ± 2.87^{a}	44.83 ± 2.03^{b}	36.31 ± 4.61^{d}	33.98 ± 1.99^{f}
U		40.95 ± 3.91^{a}	34.52 ± 1.44^{c}	30.06 ± 1.10^{e}	30.29 ± 3.91^{f}
C	MFI	45.75 ± 4.15^{a}	46.33 ± 5.10^{c}	81.70 ± 7.99^{d}	71.00 ± 5.67^{f}
U		35.00 ± 6.12^{b}	48.00 ± 6.84^{c}	48.75 ± 5.22^{e}	57.25 ± 4.48^{f}
C	Ca^{2+}	2.92 ± 0.64^{a}	3.82 ± 0.64^{b}	4.19 ± 0.30^{c}	4.61 ± 0.93^{e}
U	(µg/g)	2.72 ± 0.28^{a}	4.15 ± 0.67^{b}	5.50 ± 0.35^{d}	8.56 ± 0.19^{f}

Means followed by the same letters $^{a-f}$ do not differ significantly ($\alpha = 0.05$)

Conclusions

Probably as a result of ultrasound treatment during *rigor mortis* period an acceleration of aging processes occurred. High values of water holding capacity obtained for sonicated sample support that hypothesis. Statistical analysis of obtained results showed no significant influence of sonication on its acidity during ageing. Differentiated technological properties of examined samples may resulted from influence of ultrasound on protein structures of meat.

Ultrasound treatment did not influence lightness, a very important meat quality parameter. Judging by the results of shear force measurements, sonication process has been shown to be effective at improving meat tenderness. As a result of ultrasound treatment an increase of free calcium ions concentration occurred. Obtained results pointed out that sonication may be an effective method of formation of technological properties of beef during ageing.

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