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THE EFFECT OF LOW-FREQUENCY AND INTENSITY ULTRASOUND ON STRUCTURE AND TEXTURE OF BEEF

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Introduction

Meat texture is one of the most important factors of quality accepted by consumers. Studies point high correlation between texture properties and sensor quality of meat and meal products. Beef is characterised by long period of after-slaughter changes that shape the respective texture. Changes of myofibril proteins, connective tissue and other components of muscle fibres affect the meat texture. Calpains and cateprins that at first decompose myofibril proteins and affect the meat quality, play the special role. The way of meat freezing and electro-stimulation have also an important role in meat texture shaping after the slaughter. In several past years, an increasing interests of ultra-sound utilisation in various branches of food-stuff industry is observed. They can be applied for changing the chemical reactions and speeding up the operations of meat processing.

Changes of meat quality after the slaughter depend on enzyme activity, mainly of calpain system depended on calcium ions amount in myofibril structure [2,4]. One of the methods that makes changes in meat faster- can be ultra-sound processing of muscle structures Ultra-sound waves influence can result from their properties during wave spreading in an acoustic field. Ultra-sound make concentrations and dilutions of substances as well as particle oscillations around balance point in particular areas of acoustic field [3].

The purpose of the present paper is to find the changes of beef texture subjected to ultra-sound operation after the slaughter.

Material and methods

Muscle samples. The samples of meat tissue were prepared from 10 cattle. Muscle semimembranosus was removed 90 minutes post mortem from cattle with ante-mortem weight of about 500 kg. It was cut into three section of about 400 g each. The first was control sample (K). The second one (U1) was sonicated for 2 minutes with 25 kHz and 2 $W \cdot cm^{-2}$ ultrasound. The third one (U2) was sonicated for 2 minutes too, but with 45 kHz and 3 $W \cdot cm^{-2}$ ultrasound.

Texture Profile Analysis [1,5]. The meat was cooked at three assigned temperatures (50, 60, 70°C) and samples were cut out of meat tissue. They were compressed in the vertical direction to the muscle fibres. Texture Profile Analysis was applied using Instron 4302 interfaced with a computer to assess meat texture. The samples (20×20×20 mm) were compressed (cross-head speed 10 $mm \cdot min^{-1}$) twice to 50% of their original height. The following parameters were calculated: hardness I (T1), hardness II (T2), cohesiveness (S), springiness (E), guminess (G) and chewiness (P). The values were means of 2 repetitions of each tested muscle.

Structure. Light Microscope. Samples (5×2 mm) were obtained and fixed in Bonin solution, dehydrated in ethanol solution and embedded in paraplast, stained with hematoxilin and eosin and observed with photomicroscope and photographed with Kodak Tri-X film at a magnification of ×100.

Mean and standard deviation were calculated according to the conventional methods of statistics. The significance of differences was assessed using Student's t-test.

Result and discussion

Obtained results on meat texture properties estimated by compression method showed the influence of tissue muscle ultra-sound operation directly after the slaughter on values of a raw and thermally processed meat texture parameters. Ultra-sound operation (2 hrs after the slaughter) caused the statistically significant increase ($p>0.05$) of all texture parameter values as compared to those in control sample.

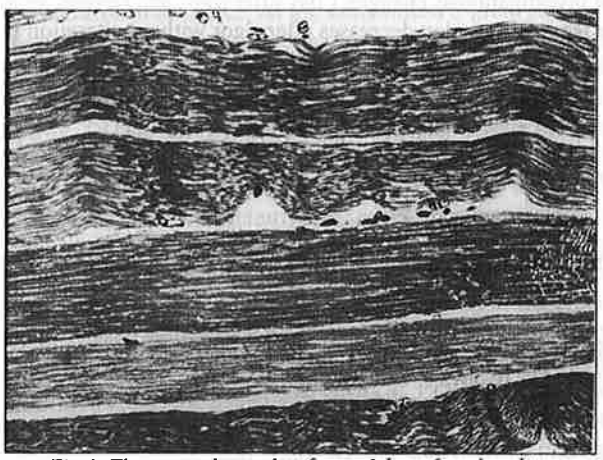

Fig.1. The control sample of meat 2 hrs after slaughter (parallel to fibres)

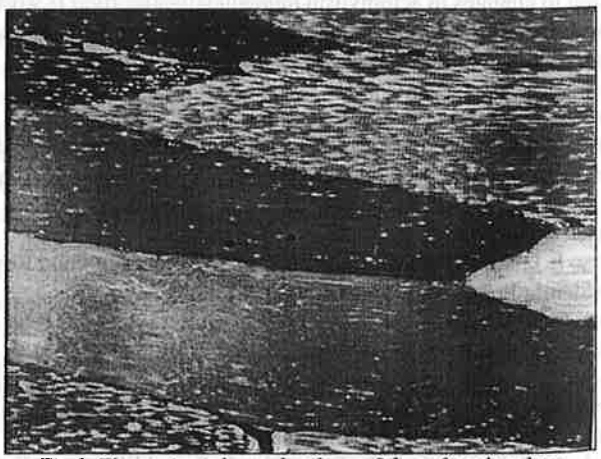

Fig.2. The sonicated sample of meat 2 hrs after slaughter (parallel to fibres)

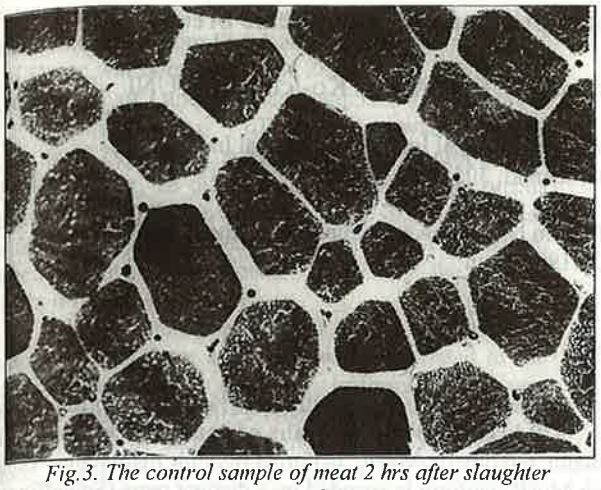

Fig.3. The control sample of meat 2 hrs after slaughter (across fibres)

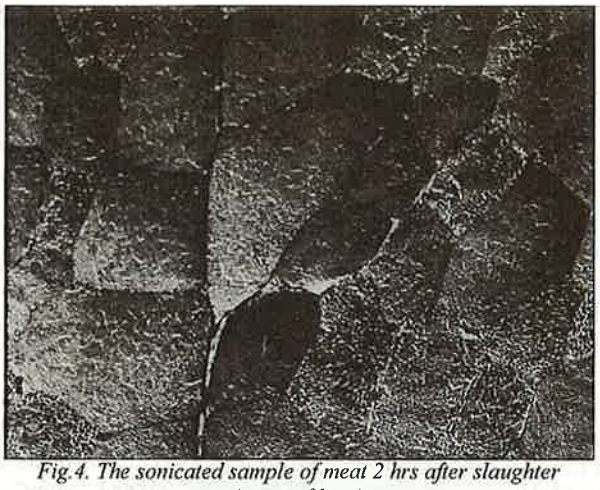

Fig.4. The sonicated sample of meat 2 hrs after slaughter (across fibres)

Study results of meat subjected to thermal processing showed that changed values of texture parameters in a raw beef affected the meat texture parameters after processing at 50, 60 and 70°C.

The highest differentiation of texture parameters between control and meat samples subjected to ultra-sound processing directly after the slaughter occurred just after the thermal processing at 60°C. Samples U1 and U2 had significantly higher texture parameter values (hardness, springiness, guminess), except from cohesiveness, that had slightly lower values in ultra-sound-operated samples (K – 0-52, U1 – 0.43, U2 – 0.44). Obtained results of beef texture parameters after the processing at 60°C point that differences of myofibrils denaturation effects on texture changes could be emphasised at that temperature. Studies upon the texture parameter changes at 70°C point that they decreased as compared to those parameters after 60°C processing. Differences between texture values of K, U1 and U2 samples were also decreased. Obtained results of texture parameters are confirmed in picture of meat macro-structure. Ultra-sound-operated sample had changed picture of muscle fibres as compared to the control.

Table 1. TPA of meat samples

Beef	Sample	T1 [N·cm^{-2}]	T2 [N·cm^{-2}]	S	E [mm·cm^{-2}]	G [N·cm^{-2}]	P [10^{-2} J·cm^{-4}]
raw meat	K	4,0	3,5	0,32	0,38	1,3	0,48
	U1	8,2	7,1	0,38	0,44	3,1	1,37
	U2	9,1	8,1	0,39	0,46	3,2	1,39
	s.s.diff.*	K-U1, K-U2	K-U1, K-U2	K-U1, K-U2	–	K-U1, K-U2	K-U1, K-U2
after cooking 50°C	K	20,7	18,4	0,48	1,03	10,9	11,2
	U1	29,8	27,3	0,47	1,12	13,9	15,6
	U2	29,7	27,4	0,47	1,14	14,1	16,2
	s.s.diff.	K-U1, K-U2	K-U1	–	K-U1, K-U2	K-U1	K-U1, K-U2
after cooking 60°C	K	45,6	39,9	0,52	1,21	23,7	28,9
	U1	58,6	50,7	0,43	1,30	25,3	32,9
	U2	58,4	51,2	0,44	1,31	24,7	32,1
	s.s.diff.	K-U1, K-U2	K-U1, K-U2	–	–	–	–
after cooking 70°C	K	39,4	36,5	0,54	1,10	21,2	23,4
	U1	49,4	46,5	0,54	1,20	26,6	32,1
	U2	48,2	47,1	0,52	1,24	25,9	30,2
	s.s.diff.	K-U1, K-U2	K-U1, K-U2	–	–	–	–

* Statistically significant differences between meat samples

Conclusion

Ultra-sound processing of meat directly after the slaughter caused the change of mechanical properties that were observed as an increase of texture parameter values

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