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Energy efficient processing

The Test for Determination of the Limit of Chilling Rapidity in Beef Carcasses.

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Background

The problem of selecting an appropriate after-slaughter chilling technology for some kinds of meat, and particularly for beef, is still c (Taylor et al., 1996; Demayer et al., 1996; White et al., 1996). Specialists in meat hygiene speak in favour of the rapid chilling technolog (Wirth, F., 1979; Roedel et al., 1980) in opposition to a widely represented group of meat experts, who have presented evidence o between the meat toughness and the **intensive** chilling of carcasses (Dransfield, S.M., 1993; Urban et al., 1995; Bendal, J.R., 1978).

The aim of this paper is to establish such microclimte parameters of the process that using them will not reduce/**depreciate** meat tend and the sanitary state of the chilled half-carcasses will be satisfactory. These parameters can be established on the supposition that no extra intervention (such as electrical stimulation, conditioning, sanitary operations), which would increase costs of production, will be app

Materials and Methods

For the purpose of the study there have been carried out two experiments concerning beef half-carcasses chilled in industrial condition every experiment, 22 heifers and steers of the Fresian breed, weighing 170-271 kg each, were used. In the experiment I, half-carcasses chilled swiftly at - 5°C for two hours, and then, at 0 - 4°C for 20 hours. Right side half-carcasses were, as a control group, chilled very s for 8,5 hours at the temperature of approximately 13°C, and from 2°C to 8°C for 13,5 hours. In the experiment II, rapid chilling at are 10°C lasted for about 6,5 hours, and in the temperature varying from 0°C to 4°C for 15,5 hours. In the experiment II, half-carcasses f control group were chilled the same way as in the experiment I.

The chilling rapidity was established according to the SE temperature decrease index in °C/h for t = 17°C, i.e. from 35°C to 18°C temperature of meat was recorded at various points of the half-carcass with the help of the Ellab apparatus .

Samples for the research were taken from the following muscle types: biceps femoris (BF) and longissimus dorsi (LD). After 48 hours mortem, meat texture was examined by taking tenderness measurements with the Warner-Bratzler apparatus and penetrometric measure (Krzywicki, 1977). Meat tenderness was also assessed sensorically on the scale from 1 to 5. In the fresh samples of the BF muscle, the of sarcomeres was measured under the microscope. In the experiment I, a total number of aerobic microorganisms at the surface of th was assessed before and after the chilling process.

Results

It has been concluded that rapid chilling applied in the experiment I (-5°C) did not have a major influence upon the sensoric tenderness examined muscles and their layers. Tougher meat in proportion to the control group was observed in the conditions of rapid chilling experiment II (-10°C), but the difference of the assessment between the groups was only approximately 0,3 point.

The results of the sensoric assessment were confirmed by the shear force value measurements of the roast samples of the BF and LD mu which differred considerably (0,01) in comparison with the control group in the experiment II only (the average difference between the being about 10 N).

The penetrometric consistence examinations of 6 layers of the BF muscle, each layer being around 15 mm thick, have shown that the c rate, used in the experiment I, did not have any influence upon the meat texture (tab. 1). In the experiment II, tougher consistenc detected down at the fourth layer of the meat chilled rapidly, that is it was found at the depth of about 60 mm off the muscle surface (0,0

Independently of chilling methods, it has been observed that the surface layer of the BF muscle, being approximately 30 mm th chracterized by tougher consistence than the deeper layers are.

The diversification of meat tenderness can be explained with the results obtained from the examinations performed under the micro (tab. 2). On the basis of the independence tests, chi-square 2 x 2, in which short (below 1,5 um) and long (over 1,5 um) sarcomeres muscle fibres were included, it can be concluded that under the microscope the **fraction** of short sarcomeres is considerably greater (0, the meat samples chilled rapidly. However, in the experiment I, this interdependence does not occur in the deeper layer of the BF muscle number of fibres having a strong contraction in various layers of the muscle is not high and constitutes only one tenth (in the experiment one third (in the experiment II) of all thefibres. It explains comparatively small differences between the beef meat tenderness chilled slow rapidly.

There may be a few causes of smaller than expected differences in meat tenderness of the beef chilled in various ways. Factors counteri cold-shortening have an impact upon the muscles in half-carcasses. Among these factors can be numbered deep location of many musc proportion to the carcass surface, and natural limitations to a strong contraction, the latter being the osseous system and a heavy muscle w upon half-carcass weight.

Microbiological studies have shown that the average total number of aerobic microorganisms at the surfaceof the hind muscles thousands per 1cm^2):

chilling method	*before chilling*	*after chilling*	*P*
rapid (-5°C)	*168,6*	*107,3*	*0,001*
slow	*138,5*	*163,5*	*0,001*

The results indicate that the degree of aerobic microbial infection of the meat surface of half-carcasses has diminished considerably at the end of the rapid chilling process. Yet, in the case of the slow chilling process there occurred a considerable increase in the number of aerobic bacteria.

On the basis of the gathered results, it can be concluded that the quantity, detected in the half-carcasses chilled rapidly by the method used in the experiment I, can be considered the limiting rate of chilling. The temperature decrease index quantities in a SE half-carcass characteristic of this method are: in the hind at the depth of 30 mm, 60 mm or in its centre are adequately 3,7°C/h, 2,6°C/h and 2,0°C/h; in the centre of the shoulder 3,1°C/h; in the centre of theloin 7,7°C/h.

Conclusions

1. Those parametres of the process, in which the value of the temperature decrease index of SE is 3,7°C/h in the hinder at the depth of 30 mm, 3,1°C/h in the centre of the shoulder, and 7,7°C/h in the centre of the loin, can be considered the limiting chilling rate of beef half-carcasses produced in Poland.

2. The chilling rate established in the first conclusion does not decrease meat tenderness and it enables to maintain a better sanitary state of the meat surface than in the case of slow chilling.

3. In the case of a further accelerating chilling rate there has been observed a repeated increase in the number of muscle fibres with a strong contraction in the meat layers situated closer to the half-carcass surface (down to the depth of about 60 mm), which implies an occurence of cold-shortening.

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Table 1. Average results of consistance measurements of different chilled beef muscles (deep to drive of needles into muscle BF, mm)

Muscle layers	Experiment 1			Experiment 2		
	quick chilling (-5°C)	slow chilling	average	quick chilling (-10°C)	slow chilling	average
1	7,53	8,37	7,95[a]	9,34	10,48	9,91[a]
2	8,59	9,51	9,05[a]	9,80	11,28	10,54[a]
3	9,60	10,05	9,83[b]	11,31	11,96	11,63[b]
4	10,56	10,40	10,48[b]	11,46	12.57	12,01[b]
5	10,22	9,75	9,99[b]	11,65	11,56	11,61[b]
6	9,99	8,79	9,40[b]	12,07	12,10	12,09[b]
All layers	9,41[a]	9,48[a]		10,94[b]	11,66[b]	

There are no significant statistical differences betwen the averages of a given item signed with the same letters

Table 2. Percentage part of short and long sarcomers in different layers of differently chilled beef muscles biceps femoris

Experiment	Layers of M. BF	Chilling methods	% part of sarcomers		chi square
			short	long	
1 (-5°C)	I	quick	6.26	40,84	10,87**
		slow	2,32	50,58	
	II	quick	7,42	39,68	13,32**
		slow	3,94	48,96	
	III	quick	7,84	40,38	0,85
		slow	10,21	41,57	
2 (-10°C)	I	quick	14,55	35,45	54,57**
		slow	1,59	48,41	
	II	quick	9,32	40,68	29,19**
		slow	1,36	40,64	
	III	quick	8,18	41,82	10,92**
		slow	3,18	46,82	

Limit point chi square at $P \leq 0,01 = 6,63$