EFFECT OF DIFFERENT THAWING RATE ON WATER HOLDING CAPACITY AND ULTRASTRUCTURE OF PORK MEAT

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Key words: Freezing; thawing; thawing loss; ultrastructure

Introduction

The freezing of meat has been widely used as an economically favorable way of meat storage. The effects of combinations of freezing, thawing and frozen storage on the drip loss and ultrastructure of pork has been studied by Ngapo, et al.(1999). They think that freezing rate was interacted with storage time in drip loss; there are no differences in the drip protein concentration and electrophoretic patterns. Ultrastructural differences of fresh and thawing samples were only observed through scaning electron microscopy, and in their article observations were only made in cross-sections perpendicular to the fibre direction. Breakage of cells might be better seen using transmission electron microscopy. In our research, transmission electron microscopy was used to observe ultrastructural differences of fresh and thawing samples. The main objective of present study was to study the effect of freezing and thawing rate on the quality of thawed pork from different resources.

Materials and methods

To determine which of the three factors, i.e., freezing rate, thawing rate or different individuals have the bigger effects on the pork water-holding capacity and ultrastructure, six pork M.Longissimus dorsi muscles from three pigs were obtained within 45 min postmortem and held at 0~4□.Each muscle was divided into equal portions (100±5g) and assigned to 6 treatment combinations using an uniform design. Thawing loss, cooking loss and ultrastructure of fresh and thawed meat were measured. All of the statistical procedures were carried out using the SPSS13.0 software.

Table 1. U_6（6×3×2）uniform design

Experimental number	Thawing rate（cm/h）	Individual	Freezing rate
1	1（0.65）	1	Fast freezing (2)
2	2（0.89）	2	Slow freezing (1)
3	3（3.16）	3	Fast freezing (2)
4	4（5.22）	1	Slow freezing (1)
5	5（5.45）	2	Fast freezing (2)
6	6（8.57）	3	Slow freezing (1)

Note: Thawing rate 1: samples were thawed in still air at 8□ in the refrigerator; Thawing rate 2: samples were thawed in still air at 23□; Thawing rate 3: samples were thawed in still water at 24□; Thawing rate 4: samples were thawed in flowing water at 21□; Thawing rate 5: samples were thawed in still water at 32□; Thawing rate 6: samples were thawed in still water at 40℃; Fast freezing: samples were frozen at -28□ in blasting air；Slow freezing: samples were frozen at -18□ in still air

Results and discussion

Thawing loss and cooking loss Mixed linear model, in which different individuals and freezing rate were fixed effects and thawing rate was random effect, was used to analyse the results of the uniform design. The results show that different individual and different freezing rate both have significantly ($p < 0.05$)effects on thawing loss and cooking loss. The results of parameter estimate were listed in table 2, using the results to adjust thawing loss and cooking loss (results not shown), Then using thawing rate (TR) and freezing rate (FR) as independent variable and adjusted thawing loss (TL) and cooking loss (CL)as dependent variable the following regression equations were obtained.

$$\mathbf{TL = -0.253+1.682\times FR+0.099\times TR^2+0.003\times TR^4-0.541\times TR\times FR \quad (R=0.952)}$$

$$\mathbf{CL=36.608-4.765\times FR-0.677\times TR+0.622\times FR\times TR \quad (R=0.774)}$$

The equations show that there were significant effects of both thawing rate and freezing rate on thawing loss and cooking loss, the effect of thawing rate and freezing rate on thawing loss was nonlinear, and there were interactions between thawing rate and freezing rate. From Fig.1 we can see the trends clearly.

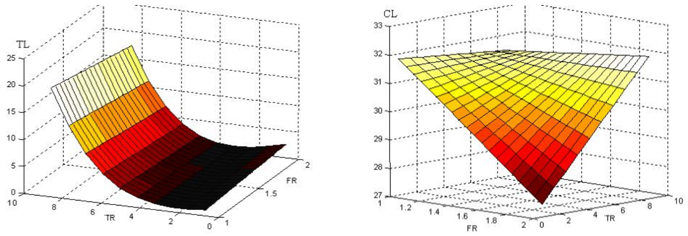

Figure 1 Effects of different freezing rates and thawing rates on thawing loss and cooking loss

Table 2 Estimates of fixed effects

Factors	Thawing loss		Cooking loss	
	Estimate	Sig.	Estimate	Sig.
Slow freezing	1.22	0.00	2.68	0.05
Fast freezing	0	.	0	
Individual 1	-0.62	0.03	7.17	0.00
Individual 2	0.29	0.28	1.34	0.31
Individual 3	0	.	0	

Ultrastructure Viewing longitudinal sections of muscles fresh and frozen and then thawed at different conditions (Fig.2), we can see freezing and thawing processing indeed had some bad effect on the ultrastructure of meat. Thawed meat showed a reduction in the density of the Z-discs and the overall integrity of the myofibril is lost, the quicker the thawing rate, the more severe the disruption, at thawing rate 6, it difficult to distinguish I-band and A-band. This is in contrast to the fresh muscle whose myofibrillar structure appeared more preserved. Reduction in the density of the Z-disc is thought to be due to proteolysis (Dutson et al., 1980). Proteolytic enzymes cause fragmentation between and within the myofibrils, due to the degradation of the costameres and I-band proteins (Taylor,et al., 1995).

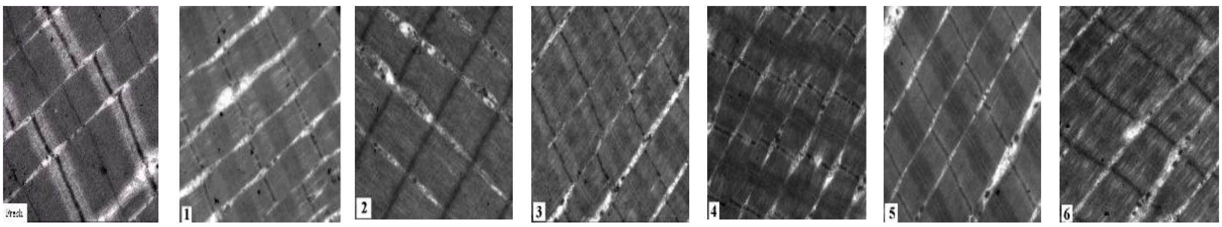

Figure 2 Ultrastructure of fresh and thawed pork muscle

Conclusions

All of the three factors considered in this experiment had significant effect on thawing loss and cooking loss. Eliminating the effect of fixed factors of different individual, we could see the effect of thawing rate and freezing rate on thawing loss and cooking loss were nonlinear, and there were interactions between freezing rate and thawing rate on both thawing loss and cooking loss, and there may be an optimum thawing rate that can decreased the thawing loss to minimum. Freezing and thawing processing indeed had some bad effect on the ultrastructure of meat. Thawed meat showed a reduction in the density of the Z-discs and the overall integrity of the myofibril is lost, the quicker the thawing rate, the more severe the disruption.

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