STUDIES ON THE THERMAL DENATURATION OF FREE DRIP RELEASED FROM NORMAL AND PSE PORK MUSCLE

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INTRODUCTION

It has been reported that drip is the most important factor reducing meat quality (Penny, 1977; Goutefongea, 1967). The amount of drip is related to the degrees of denaturation of muscle proteins casused by the rate and extent of acidification after slaughter (Penny, 1977). Especially, the initial rate of pH fall in pig muscles effects on drip loss (Warris & Brown, 1987) and drip results in protein loss (Penny, 1975, 1977). Such a drip could be derived from sarcoplasmic part in origin and the increase of drip amount may be caused by conformational changes of some proteins (Andrew et al, 1990). Although the mechanism of drip formation has been reviewed (Offer & Knight, 1988), it is not still clear. To determine the relationship between protein denaturation and drip loss(%), we have examined the characteristics of the thermal denaturation on free drip released from normal and PSE pork muscle during chilled storage.

MATERIAL AND METHOD

For this experiment, we collected loins from 216 pigs (Large White and Landrace) slaughtered with normal commercial practices. A section of the *M. longissimus dorsi* posterior to the last rib was removed after chilling at 2℃ for 24h, and enveloped in polypropylene bag for the estimation of drip loss (DL). The amount of drip was calculated by measuring the loss in weight of sample after 72h, and expressed as a percentage of the initial weight. The sample was devided into two groups (NORD, 4%<DL<7%; PSED, DL>13%) by measuring the drip amount in the bag. Drip extract was centrifuged at 3,000 rpm for 15 min and filtered with Watman paper (No. 4). And pH, protein concentration, and pigment content in drip were examined. Protein concentration was determined by Lowry method (Lowry et al, 1951) and pigment content was analysed by determination the myoglobin content. To evaluate the thermal denaturation of drip in NORD, we determined the thermal curves using DSC (Perkin-Elmer, Germany) with various conditions as follows: drip loss (%), heating rate, preheating, pH, NaCl or sodium tripolyphosphate concentration.

RESULTS AND DISCUSSION

pH and protein concentration in drip of PSED was lower than that of NORD, while total protein loss was higher in PSED. Total pigment amount did not show significant differences between NORD and PSED (Table. 1). When NORD and PSED were evaluated with DSC, the denaturation temperature of the first minor peak (T_1) of PSED drip was lower by 2.5℃ than that of NORD, and the $\triangle H_2$ was reduced by 3.8% in PSED as compared with NORD (Fig. 1, Table 2). Increasing the heating rate from 5 to 40 ℃/min significantly elevated the onset temperature and the transition temperature, as well as the enthalpy for denaturation of NORD (Fig. 2). Enthalpy of the drip which was heated upto various end-point temperatures, cooled, and reheated in the DSC showed reduction of total enthalpy by 77% at 70℃ (Fig. 3). The temperature of T_1 was significantly increased with increasing pH from pH 5.0 to 7.0 and sodium tripolyphosphate (STPP) concentration from 0 to 0.5%, but decreased with increasing NaCl concentration from 0 to 5% (Fig. 4-6). When increaed the temperature of drip from 40 to 60℃, lightness (L^*) of drip was increased by 78%, but redness (a^*) was significantly decreased (Fig. 7). These results suggest that the denaturation of sarcoplasmic protein in pork meat may be effect on drip occurence.

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Table 1. Amount of Drip, pH, Protein Concentration, Total Amount of Protein loss and Pigment for Free Drip of 216 Pork Loin Muscles.

Drip (n=24)	Amount of drip (%)	pH of drip	Portein concentration (mg/ml)	[4]Total amount of protein loss (mg/100g muscle)	Total amount of pigment (μg/ml)
NORD[1] (n=12) Mean[3] ± Std. dev.	5.72±0.90	5.79[a]±0.13	81.97[A]±15.79	468.87[b]±14.21	52.81[a]±6.84
PSED[2] (n=12) Mean±Std. dev.	14.77±1.54	5.57[b]±0.07	61.23[B]±6.20	904.38[a]±9.55	49.35[a]±2.73
Mean±Std. dev.	10.25±3.18	5.68±0.16	71.60±13.83	-	51.08±4.28

[a, b] : Within same column, means with different superscripts are significantly different. (P<0.05)
[1]NORD : Normal Pork Drip, 4%<drip loss<7%
[2]PSED : Pale, Soft and Exudative Pork Drip, drip loss>13%
[3]Means of four replicate determinations
[4]Total amount of protein loss was calculated as follows: Protein concentration × amount of drip

Table 2. Onset Temperature (To), Thermal Transition Temperatures (T_1, T_2, T_3) and Apparent Heat Transition Energies (ΔH_1, ΔH_2, ΔH_3, ΔH_{tot}) for Free Drip of Pork Loin Muscles. (Heating rate=20℃/min)

Drip (n=25)	Temperature of transition (T_{max}, ℃)				Heat energy of transition (ΔH_{app}, mg/ml drip)			
	T_o[4]	T_1	T_2	T_3	ΔH_1	ΔH_2	ΔH_3	ΔH_{tot}
NORD[1] (n=12) Mean±Std. dev.	63.13[a]±0.92	61.46[a]±1.81	71.69[a]±0.86	84.25[a]±2.17	0.56[a]±0.09	1.52[a]±0.08	0.82[a]±0.07	2.90[a]±0.14
PSED[2] (n=13) Mean±Std. dev.	62.42[a]±1.19	58.94[b]±1.75	70.83[b]±0.73	84.71[a]±1.83	0.60[a]±0.06	1.37[b]±0.08	0.82[a]±0.06	2.79[b]±0.12
Mean[3]±Std. dev.	62.77±1.10	60.10±2.16	71.23±0.89	84.50±1.97	0.58±0.09	1.44±0.09	0.82±0.08	2.84±0.14

[a, b] : Within same column, means with different superscripts are significantly different(P<0.05)
[1]NORD : Normal Meat Drip, 4%<drip loss<7%
[2]PSED : Pale, Soft and Exudative Pork Drip, drip loss>13%
[3]Means of four replicate determinations
[4]To : Onset temperature of transition

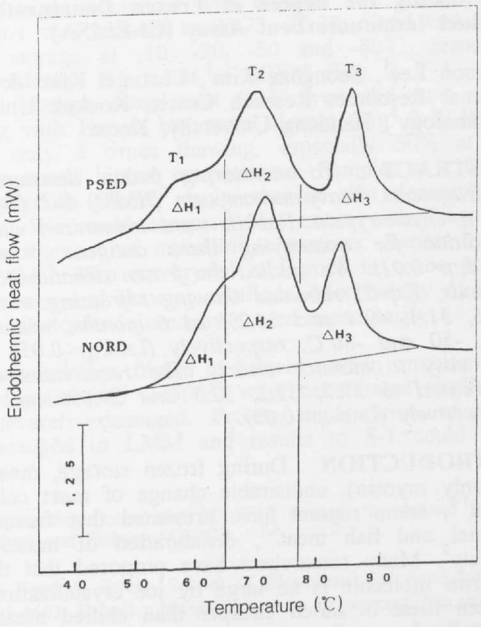

Fig. 1 DSC Thermal Curves for Free Drip of Pork Loin Muscle. Segmentation ($\triangle H_1$, $\triangle H_2$ and $\triangle H_3$) used for Calculation of Apparent Enthalpies is indicated (see Table 2) : NORD (normal pork drip), 4%<drip loss<7%, PSED (pale, soft and exudative pork dirp), drip loss> 13%. (Heating rate = 20℃/min)

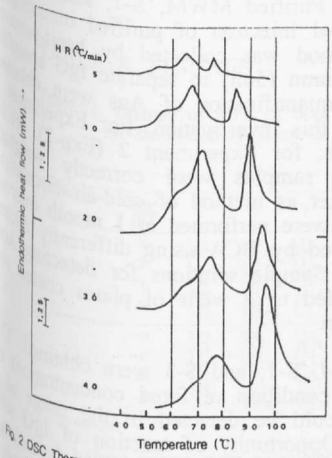

Fig. 2 DSC Thermal Curves for Free Drip of Pork Loin Muscle heated at Different Rate (HR, ℃/min).

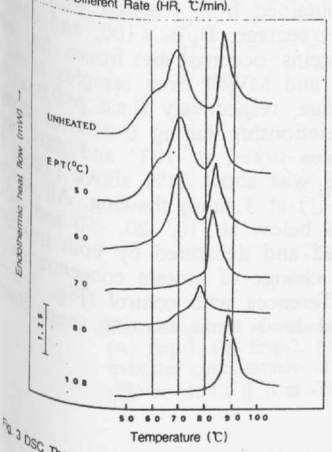

Fig. 3 DSC Thermal Curves for Free Drip of Pork Loin Muscle heated to Different End-point Temperatures (EPT), cooled, and reheated in the DSC to 108℃. (Heating rate = 20 ℃/min)

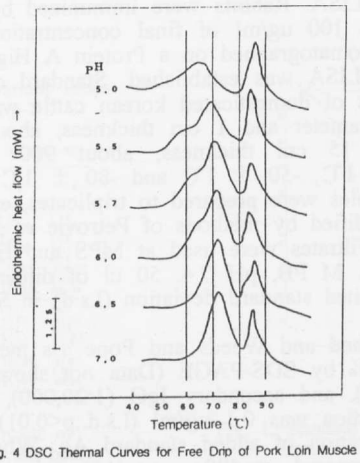

Fig. 4 DSC Thermal Curves for Free Drip of Pork Loin Muscle at different pH. (Heating rate = 20 ℃/min)

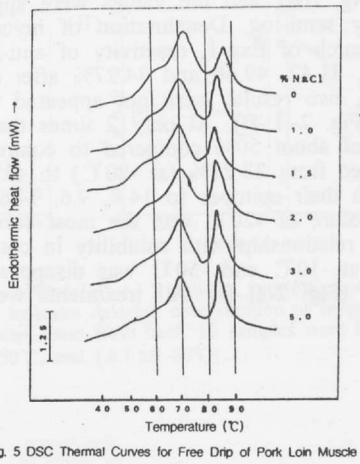

Fig. 5 DSC Thermal Curves for Free Drip of Pork Loin Muscle treated with Various NaCl Concentrations. (Heating rate = 20 ℃/min)

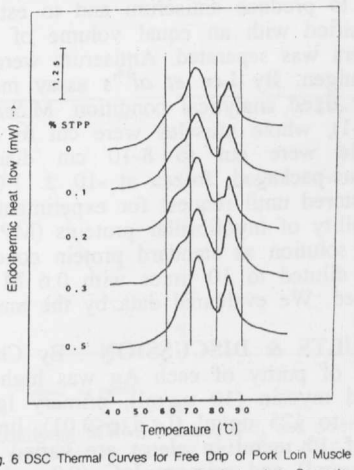

Fig. 6 DSC Thermal Curves for Free Drip of Pork Loin Muscle treated with Various Sodium Tripolyphosphate Concentrations (STPP). (Heating rate = 20℃/min)

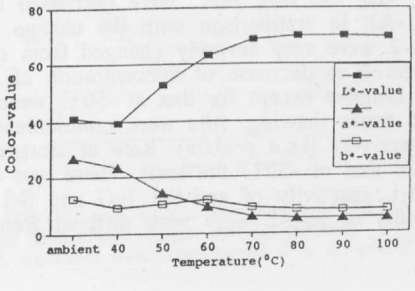

Fig. 7 Changes in Color Values (L*-, a*- and b*-value) of Free drip of Pork Loin Muscles at respective Temperature. (Heating Rate = 1℃/min)