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Effects of Brine Immersion Ohmic Thawing Process on Physico-Chemical Properties of Frozen Pork

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Introduction

Ohmic heating is a food processing method in which an alternating electrical current is passed through an electrically conducting food sample and the inherent electrical resistance of the material generates heat (Biss *et al.*, 1989). This produces a heating pattern from within the food, which is much faster than conventional outside heating. Ohmic heating is somewhat similar to microwave heating but with very different frequencies (de Alwis and Fryer, 1990). The advantage of ohmic heating is that it uniformly heats in contrast with the non-uniform distribution of microwave heating (Datta and Hu, 1992; Morrissey and Almonacid, 2005). Numerical literatures are dealing with ohmic processing as novel heating methods, while few researches in thawing regions are reported. Kim *et al.* (2006) reported that plate contact ohmic thawing up to 50 V improved qualities of hamburger patties, and Yun *et al.* (1998) also found that water immersion ohmic thawing at 60 V improved water binding properties of frozen meat chunk. However, overheating of food during ohmic procedure is the most important problem. Therefore this study was carried out to investigate the effect of brine immersion thawing process combined ohmic thawing unit at low voltage on physico-chemical properties of frozen pork meat.

Materials and Methods

Porcine *m. longissimus dorsi* stored for 24h after slaughter was trimmed all visible fat and connective tissue. For each treatment, rectangular formed samples (15×30×80 mm) were cut from the centre of the muscle with their axis parallel to fiber direction. All samples had thermocouples inserted into their centre, along the longitudinal axis of the

sample, and vacuum-packed with polyethylene bag. Freezing was conducted in deep freezer (Nihon Freezer, Japan) maintained at −50°C for 24 h. Thawing treatments were carried out at 30 V using ohmic thawing equipment consisted of sample holder, copper electrode, temperature recorder, and AC power source (ACP-1010, AC Power Korea Co., Ltd., Korea) as described in Fig. 1. Electric conduction medium used was brine up to 10 g/L NaCl concentration. Both meat and brine temperature changes were measured during ohmic thawing treatment. Thawing time was determined to arrive at 0°C in centre temperature of samples. Water holding capacity (WHC), shear force and colour were determined. The results from triplications were analyzed by ANOVA using SAS statistical program 9.1 (SAS Institute, Cary, NC, USA).

Result and Discussion

Effect of brine immersion ohmic thawing on time-temperature profile of pork and temperature increasing rate of brine are given in Fig. 2. As expected, thawing rate showed logarithmic increase with increasing NaCl concentration, whilst temperature increasing rate of brine increased linearly. The result was in agreement with Kim *et al.* (2006) who reported that increasing in ohmic power intensity (voltage) caused increased thawing rate. In addition, thawing rate in this study was more rapid than that of Kim *et al.*, (2006) even at 0 g/L NaCl concentration. Although this study was conducted at constant voltage (30 V), increasing NaCl concentration possibly caused increased electric conductivity, leading to rapid thawing.

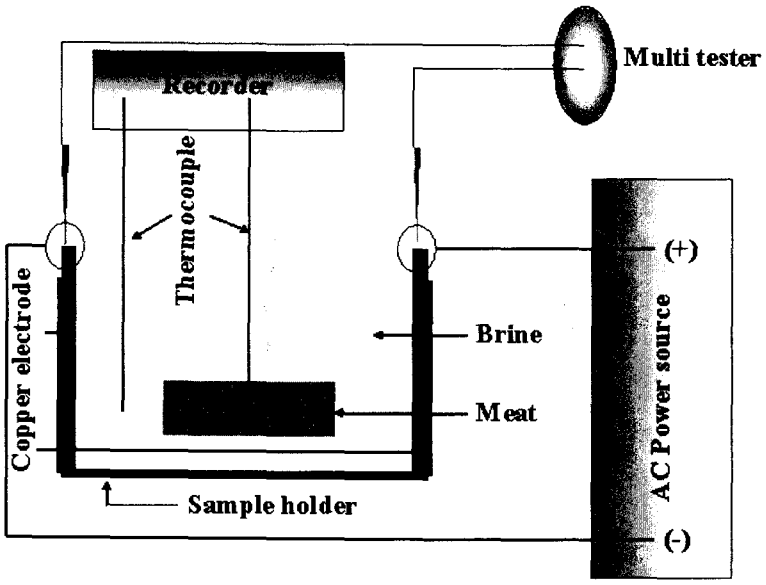

Fig. 1. Schematic diagram of ohmic combined with brine immersion thawing equipment.

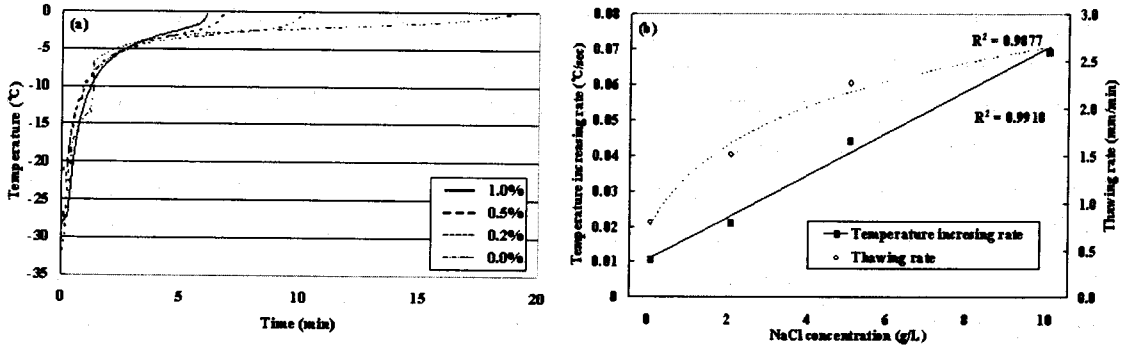

Fig. 2. Effect of brine immersion ohmic thawing on (a) time-temperature profile of meat and (b) temperature increasing rate of brine.

Effect of brine immersion ohmic thawing on water holding capacity (WHC) and shear force of pork meat are given in Fig. 3. Moisture content of all treatment did not differ significantly ($p>0.05$) and ranged from 74.54 to 75.38 %. In WHC, no significant differences among treatments were found excepted between 5 and 10 g/L NaCl concentration. In the current study, the highest WHC was obtained at 10 g/L NaCl concentration. This was possibly due both to swelling of muscle fiber and thus to hold more water into meat structure as described from Graiver *et al.* (2006). In addition, Hong *et al.* (2005) postulated that increasing thawing rate improved WHC of meat, and in agreement with this study. Increased WHC led to decline in shear force of meat. Shear force tended to decrease with increasing NaCl concentration and significant decrease was found at 5 g/L NaCl concentration ($p<0.05$). In consequence, improved WHC could cause reduced cooking loss and therefore increased meat tenderness (Hong *et al.*, 2006).

Table 1 represented the effect of brine immersion ohmic thawing on colour of pork meat. Addition of NaCl in brine decreased all colour parameters significantly ($p<0.05$) with the comparison of 0 g/L NaCl concentration. However, no significant differences among NaCl

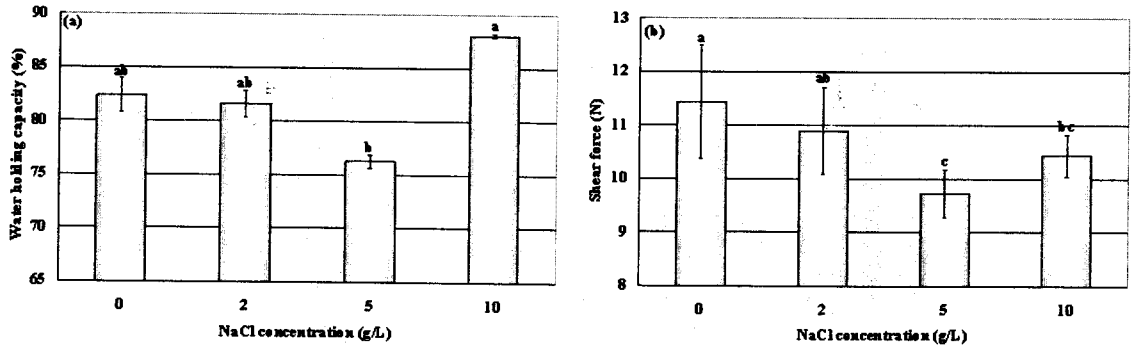

Fig. 3. Effect of brine immersion ohmic thawing on (a) water holding capacity and (b) shear force of pork meat.

Table 1. Effect of brine immersion ohmic thawing on colour of pork meat

CIE colour	NaCl concentration (g/L)			
	0	2	5	10
L^*-value	54.2±0.7^{a}	49.5±1.0^{bc}	50.5±0.3^{bc}	46.7±1.9^{c}
a^*-value	7.0±0.8^{a}	3.9±0.5^{d}	4.6±1.0^{bcd}	4.4±0.5^{cd}
b^*-value	7.3±0.7^{a}	4.9±0.8^{b}	6.0±0.5^{b}	5.8±0.5^{b}

$^{a\sim d}$ Means with different letters within the same raw are significantly different ($p<0.05$).

added treatments were found ($p>0.05$) in colour. In general, addition of NaCl in meat make meat colour darker and therefore lower colour values in brine solution than 0 g/L NaCl concentration represented penetration of NaCl into meat during thawing processing.

Summary

In the current study, ohmic combined with brine immersion thawing increased thawing time than plate contact type ohmic thawing even at low voltage. Moreover, rapid thawing resulted in high WHC and improved meat tenderness. The result indicated if the problems in safety would be solved, brine immersion type ohmic thawing could reduce processing time in industrial application promising both improved meat qualities and successful application in meat industry, and further works were needed.

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