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Effects of Salt, Glucono-δ-Lactone and High Pressure Treatment on Binding Properties of Restructured Pork

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Introduction

Restructuring of meat products enables the use of less valuable meat components to produce palatable meat products at reduced cost (Tsai *et al.*, 1998). Meat to meat binding in restructured meat products may be achieved through the formation of gels that set thermally (hot-set) or chemically (cold-set). Although conventional restructured meat products depend on hot-set binding of myofibrillar proteins that are extracted from meat with the combined effects of salt, phosphate and mechanical action (Boles and Shand, 1998), this system can not bind in the raw state (Means and Schmidt, 1986). Numerical reports are dealing with the effect of transglutaminase (TGase) on cold-set binding. Nielsen *et al.* (1995) found that TGase improved the binding strength at 37°C, while no significant effect at below 10°C. Therefore the use of food binders (Boles and Shand, 1998; Clarke *et al.*, 1988) and freezing treatment (Sheard, 2002) are needed to achieve palatable binding or handling. However freezing treatment has deteriorations due to drip loss and more processing time for thawing. Carrageenan can improve the binding properties of restructured meat products. Montero *et al.* (2000) suggested that carrageenan formed a continuous structure inside the cavity of meat gel, and Nishinari and Takahashi (2003) classified carrageenan as cold-set binding agent. Cold-set binding through high pressure also can be achieved due to gelation of myofibrillar protein. However, Hong *et al.* (2006) reported that proteins showed no binding properties at 200 MPa of pressure level when thermal processing at least 50°C was not applied. Washing, which are applying in surimi industry, can improve the binding strength of restructured meat products due to remove the sarcoplasmic protein and therefore to enhance myofibrillar protein in raw meat (Park and Morrissey, 2000). Nevertheless salt is critical for the extraction of salt-soluble proteins which provide palatable binding between meat particles in meat restructuring. The addition of glucono-δ-lactone (GdL) to meat system can achieve acid-induced gelation of myofibrillar protein via dialysis of acid into a myosin system (Ngapo *et al.*, 1996). Therefore this study was carried out to investigate the effect of NaCl and GdL on cold−set binding of restructured pork meat washed and pressurized at 200 MPa for 30 min.

Materials and Methods

Porcine *m. longissimus dorsi* stored for 24 h after slaughter was purchased from local meat market. Meat was frozen at −50°C for 24 h and thawed at 4°C for 48 h. Meat was trimmed visible fat and connective tissue, and cut into 1 cm cubes. Washing process was conducted by the method of Mackie (1992). Water gain and protein loss was determined at each washing stage. To manufacture the restructured pork, all treatment was added 0.5% carrageenan and 0.3% sodium tripolyphosphate. Another ingredients added were no added control (C), 1% NaCl (S), 1% GdL (G), 0.5% NaCl and 0.5% GdL (LSLG), 0.5% NaCl and 1.5% GdL (LSHG), 1.5% NaCl and 0.5% GdL (HSLG) and 1.5% NaCl and 1.5% GdL (HSHG), respectively. All treatment was mixed by hand for 5 min, filled into fibrous casing and vacuum packed with polyethylene bag, and then stored at 4°C for 30 h. Pressurisation was carried out at 200 MPa for 30 min under ambient temperature. Binding strength, pH and water holding capacity (WHC) were determined. The results were analysed by ANOVA using SAS statistical program 9.1 (SAS Institute, Cary, NC, USA).

Results and Discussion

1. Water Gain and Protein Loss during Washing Process

Water gain and protein loss during washing process are given in Fig. 1. Water gain was

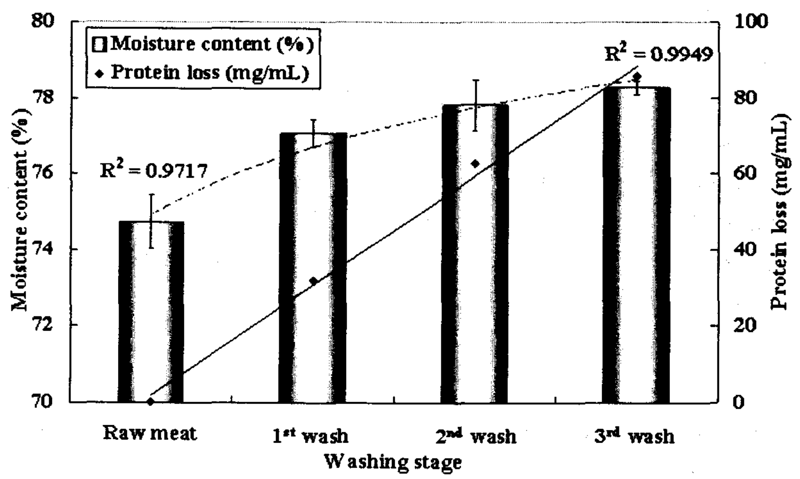

Fig. 1. Changes in moisture content and protein loss during washing process of raw meat.

increased significantly after 1st washing stage and then slightly increased with undergoing further washing process. However, protein loss showed linear increase with washing process. Although severe washing could cause some myofibrillar protein loss, most of protein loss was considered sarcoplasmic proteins. Therefore, improved WHC and enhanced myofibrillar protein in raw meat were expected by washing process.

2. Binding Strength

Effects of NaCl and GdL on binding strength of restructured pork meat are given in Fig. 2. As expected, no measurement could be taken in control. However, both NaCl and GdL increased binding strength of restructured pork. In the current study, G treatment showed the lowest binding strength, 3.13 N. However, this value is high enough to handling at raw state. This high binding strength was possibly due both to acid-induced gelation and to enhance myofibrillar protein through washing processing. Among combined NaCl and GdL treatments, NaCl showed more significant effect on binding strength than GdL. Moreover, GdL showed no significant effect on binding strength ($p>0.05$), when high NaCl was added in restructured meat. Therefore the result indicated although NaCl was critical additives in meat restructuring, palatable binding strength could be obtained with the combination of NaCl and GdL even if low concentration was added.

3. Water Holding Capacity and pH

Effects of NaCl and GdL on water holding capacity and pH are given in Fig. 3. WHC of restructured pork was increased significantly by NaCl added ($p<0.05$) compared to control, whilst the addition of GdL above 1% showed significant decrease irrespectively with NaCl added. However, high GdL treatments showed higher WHC than only GdL added treatment,

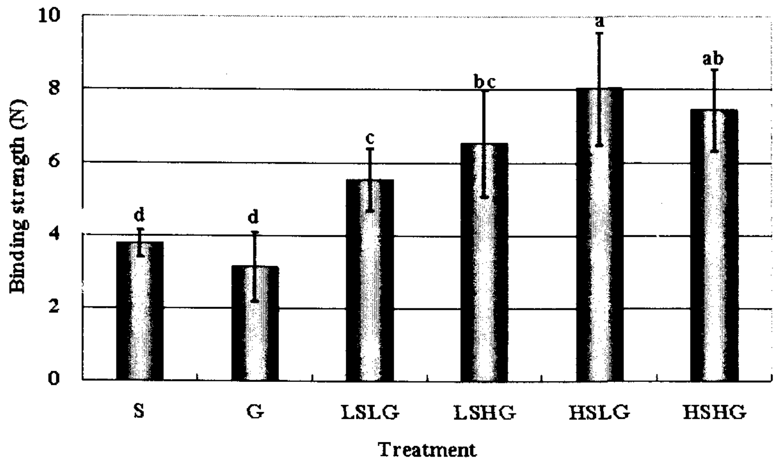

Fig. 2. Effects of NaCl and glucono-δ-lactone level on binding strength of restructured pork washed and pressurized at 200 MPa. Different superscripts are significantly different ($p<0.05$).

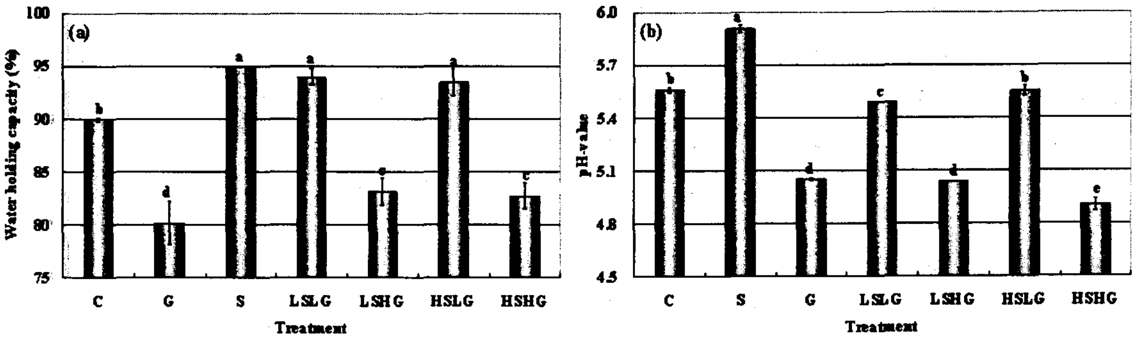

Fig. 3. Effects of NaCl and glucono−δ−lactone level on (a) water holding capacity and (b) pH of restructured pork washed and pressurized at 200 MPa. Different superscripts are significantly different (p<0.05).

when NaCl was added simultaneously. The WHC of restructured pork showed significant correlation with pH. The highest pH was found at S treatment, while the lowest at HSHG treatment. In the current study, high pH from S treatment was possibly due to phosphate added. NaCl combined with phosphate caused better extraction of myofibrillar protein leading to increase in binding strength and WHC. In contrast, GdL decreased pH by dialysis from raw meat pH to isoelectric point of meat and therefore mininised between water and protein leading to decrease in WHC. Above result indicated although GdL decreased WHC and pH of restructured pork, all treatments showed above 80% of WHC probably due to washing, pressurization and carrageenan added. In addition, 0.5% GdL treatments showed higher WHC than control implicating potential benefit in meat restructuring.

Summary

In the current study, the addition of either NaCl or GdL increased the binding strength and it considered that the use of GdL with or without low NaCl concentration improved the binding strength of restructured pork meat. Major deterioration of GdL addition is cooked−like discoloration. However, the combination with washing process or addition of carrageenan could improve cold−set binding properties of restructured pork, even if low NaCl or GdL were added.

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