Effects of high hydrostatic pressure with reducing sodium chloride on physicochemical properties of pork gels

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Objectives: Sodium chloride (NaCl) is one of the most widely used additives in the food processing sector. Currently, the daily sodi- um intake is approximately three times the recommended daily allowance for an adult, and processed meat products contribute to about 20-30% of the total sodium dietary intake. In recent years, consumer concerns regarding high levels of sodium chloride in- take have increased, given the associated risk of cardiovascular disease. However, due to the essential functions (flavor, texture, and shelf-life) provided by salt in meat products, the effects of reducing the amounts of salt used must be carefully considered. The processed meat products utilize the heat-gel-forming ability of myofibrillar proteins, and the myofibrillar proteins solubilized by the addition of salts form a three-dimensional network structure by heating. The denser of the mesh structure, the greater the amount of water and fat that can be retained. Thus, juicy and soft texture with unique taste and flavor of processed meat products can be obtained. A combination of multiple tools could give the desired effect; in particular, novel technological treatments such as high hydrostatic pressure technology, seem to be promising to ensure microbiological safety, modification the texture properties, improvement the water-holding capacity in low sodium meat products. High pressure application has been shown to act on myofibrillar proteins in a similar manner to salt or phosphate; both sodium chloride and phosphates could be reduced by this method. Therefore, the purpose of this study was (1) to investigate the effects of high hydrostatic pressure treatment on the physicochemical properties of pork gels and (2) to determine the appropriate high hydrostatic pressure conditions.

Materials and Methods: In this research, frozen pork (ham) from Marudai Food Co., Ltd was used in the present study. The pork was chopped through a 16.0-mm, then 3.2-mm plate using a mincer machine. The chopped meat was mixed with sodium chloride (0-2%) and/or sodium phosphate ($Na_4P_2O_7 \cdot 10H_2O$) (0-0.5%), in certain concentrations of sodium chloride and sodium phosphate for each sample. The application of a high hydrostatic pressure technology (0.1-200 MPa, 10 min, at room temperature) was used, and unpressurized pork gels were expressed as the pork gels treated under 0.1 MPa. To analyze the technological properties, the pork gels were cooked in a water bath at 80 °C for 30 min to reach a temperature of 70 °C at the meat sample center and cooled down with ice-cold water until the core temperature of the meat samples reached 20 °C (about 15 min), before their characteriza-tion. Measurement items were appearance, color, water content, cooking losses, pH, and texture parameters of meat samples.

Results and Discussion: At pressure levels <200 MPa, there was only a very slight color change in comparison to unpressurized meat. The structural modifications by high pressure led to changes in the ratios of absorbed, diffracted, and reflected light, resulting in increased light scattering. Pressurized pork gels containing the 1% sodium chloride with 0.5 % sodium phosphate addition modified values of cooking losses close to those of pork gels containing 2% sodium chloride with 0.5 % sodium phosphate addition. Presence of the sodium chloride and sodium phosphate greatly influenced the cooking losses of thermal pork gels following high pressure treatment. Without salt, high pressure had no positive effects on the cooking losses of meat samples, but high pressure treatment synergized with sodium chloride and/or sodium phosphate decreased the cooking losses. The highest values of hardness, cohesiveness, breaking stress, and modulus of elasticity were observed under high pressure treatment at 200 MPa, thus the reduction of sodium chloride concentration led to an improvement in the textural parameters in pressurized samples. These results indicate that the sufficient elasticity of pork gels at low sodium chloride concentration is achieved using hydrostatic pressure at 200 MPa.

Conclusion: The results of the present study suggest the possibility of developing low sodium chloride meat products by high pressure treatment at 200 MPa. However, reducing the sodium chloride and sodium phosphate led to a slight increase in the cooking losses for pressurized pork gels.

Key words: High hydrostatic pressure, Sodium chloride, Pork gels, Physicochemical properties