Effect of high pressure processing on the physicochemical properties and sensory evaluation of low-salt pork gels.

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I. INTRODUCTION

Excessive intake of sodium chloride (NaCl) is known to elevate blood pressure, a significant risk factor for cardiovascular and kidney diseases. Between 1982 and 2015, there were 10,414 participants (ranging in age from 18 to 88 years, of whom 50% were female) from 34 different countries, with twelve studies from European and North American countries; twelve from Asian countries; and one from each of the following countries/regions: Australia, New Zealand, Brazil, and the Seychelles Islands; as well as one region with a mixed population. The average salt intake per person was 9.3 grams per day, based on 24-hour urine samples [1]. The World Health Organization (WHO) recommends a limit of 5 g/day of NaCl. Approximately 77% of consumed sodium originates from processed foods [2], with meat and meat products contributing 20-30% of common salt intake [3,4]. Sodium polyphosphate, containing 31.2% sodium compared to 39.3% in NaCl, is typically used at 0.5% compared to salt's 2-6% usage rate in meat products [4,5].

Meat products represent a significant portion of high-pressure processing (HPP) in the food industry, comprising 25-30% of all high-pressure processed foods [6]. High hydrostatic pressure treatment offers opportunities for enhancing the functional properties of myofibrillar proteins and reducing salt and/or phosphate content in gel-type meat products. Studies have shown that HPP has a similar effect on myofibrillar proteins as salt or phosphate, reducing NaCl and sodium phosphate (SPP) [7]. For instance, pressurization at 200 MPa before heat treatment boosted the rheological properties of low-salt (1%) pork sausages [8]. Similarly, HPP following cooking produced low-salt (1%) beef sausage with improved texture and sensory acceptability [9]. Controlling the pressure gradient significantly impacted the functional properties of pork meat batters, enabling a 50% reduction in salt content without compromising product quality [10]. Apart from these studies, in addition to salt pressurized gel-type pork has not been investigated.

Therefore, the objective of this study was to investigate the effects of HHP treatment combined with sodium chloride and sodium phosphate on the physicochemical properties and sensory evaluation of low salt and low phosphate pork gels.

II. MATERIALS AND METHODS

Canadian frozen pork (pork leg) was utilized in this study. The pork was minced through a 16.0 mm, then 3.2 mm plate using a mincer machine. The minced meat was mixed with varying concentrations of sodium chloride (0-2%) and/or sodium phosphate ($Na_4P_2O_7 \cdot 10H_2O$, 0-0.5%) for each sample. High hydrostatic pressure treatment (0.1-200 MPa, 10 min, at room temperature) was applied, with unpressurized pork gels treated under 0.1 MPa. Following HPP treatment, the pork gels were cooked in a water bath at 80 °C for 30 minutes, and then cooled with ice-cold water until the core temperature reached 20 °C before characterization. Measurement items included texture analyses, rheological characteristics, sensory evaluation, Scanning electron microscopy (SEM), SDS-PAGE analysis and Differential scanning calorimetry (DSC) parameters of meat samples.

III. RESULTS AND DISCUSSION

1. Texture analyses: The highest values of hardness, cohesiveness, breaking stress, and modulus of elasticity were observed under high-pressure treatment at 150-200 MPa. These results also indicate

that the use of high pressure of 150-200 MPa can result in sufficient elasticity of pork gels at low salt concentrations.

2. Rheological characteristics: After high-pressure treatment at 150 MPa, the G' and G" of pork gel containing 1% NaCl and 0.5% SPP were higher than those of pork gel containing 2% NaCl and 0.5% SPP without HPP. This suggests that halving the salt (1% NaCl and 0.5% SPP) at 150 MPa also resulted in stronger gels.

3. SEM: Good network structure formation was observed with 2% NaCl and 0.5% SPP, as well as at 150-200 MPa pressure with half as much salt (1% NaCl and 0.5% SPP), indicating successful network structure formation despite reduced salt concentration.

4. Sensory evaluation: The sensory quality of pork gels was assessed and based on several sensory attributes including eating texture and flavor. The results indicated that when the addition of sodium chloride was reduced by 1%, the 150-200 MPa-pressurized pork gel received the high evaluation for the "elasticity" and " Pleasant taste" items compared to the unpressurized pork gel with 2% salt content. Panelists noted that the pork gel with 2% salt content was very salty although comparable to the taste of commercially available meat products. On the other hand, the pork gel with 1% salt content after high-pressure treatment not only improved the elasticity but also effectively controlled the salt content.

5. SDS-PAGE analysis: Following HPP at 100-200 MPa, a decrease in the density of α-actinin band was observed. The HPP at 150-200 MPa before heating improved the rheological properties of pork sausages by disrupting the structure of muscle fibers and dissociating fibrils.

6. DSC: A gradual decrease in total enthalpy of thermal denaturation of pork with increasing pressure was observed, suggesting easier denaturation of pork myofibrillar proteins.

IV. CONCLUSION

HPP at 150 MPa prior to heating enhanced the texture and rheological properties of pork gels. This study demonstrates that high-pressure treatment around 150 MPa in ready-to-eat meat products may modify food properties, with potential applications extending to similar meat products.

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