COMBINED EFFECT OF HIGH HYDROSTATIC PRESSURE WITH REDUCED SODIUM CHLORIDE AND SODIUM PHOSPHATE CONTENT ON THE STRUCTURE AND PALATABILITY OF BEEF GELS

A.Maksimenko[1*], R. Kikuchi[1], S. Tsutsuura[2], and T. Nishiumi[1],

[1]*Graduate School of Science and Technology, Niigata University, Niigata, Japan*,

[2]*Institute for Research Promotion, Niigata University, Niigata, Japan*,

*anastasia.2603@mail.ru

I. OBJECTIVES

The objective of this study was to investigate the effects of high hydrostatic pressure (HHP) treatment (100–200 MPa, 10 min, 20°C) in combination with sodium chloride (0%–2%) and sodium phosphate (0%–0.5%) addition on the microstructure, sensory characteristics, and free amino acid content of beef gels.

II. MATERIALS AND METHODS

Meat batters were prepared from minced beef with the addition of various concentrations of sodium chloride (NaCl) (0%–2%) and sodium pyrophosphate (SPP) (0%–0.5%) and subjected to HHP treatment at 0.1–200 MPa for 10 min using a high-pressure food processor (Dr. CHEF, Kobe Steel, LTD, Japan). After that, the heat treatment was carried out at 80°C for 30 min and, finally, cooled down with ice water to the temperature at the center −20°C. Sensory evaluation was conducted by students and staff of Niigata University (an untrained panel of 11–13 healthy men and women in their twenties) using the Scheffe paired comparison method. Participants were asked to assess the softness, juiciness, no residual taste, easy to swallow, cohesiveness, moistness, springiness (elasticity), pleasant odor, and pleasant taste of thermal beef gels on a 7-point scale from −3 ~ +3. Friedman's test was used to compare the significant differences between the score for each evaluation item at the 5% level. The microstructure of thermal beef gels was examined using a scanning electron microscopy (JSM-6510LA, JEOL, LTD, Japan). The free amino acid content was analyzed using an amino acid analyzer (JLC-500/V, JEOL, LTD, Japan). A confidence level of 5% was used to compare significant differences among means using Student *t* test.

III. RESULTS

A large number of muscle fiber fragmentations and coarse protein aggregates were observed in the unpressurized beef gels containing 0% sodium chloride and/or 0% sodium phosphate (Figure 1a). On the other hand, the beef gels treated by high pressure at 150 MPa contained many solubilized filaments that formed filamentous network structure (Figure 1b). Compared to the control beef gel containing 2% NaCl + 0.5% SPP (Figure 1c), the low-salt and/or low-phosphate beef gels treated at 150 MPa contained an overlapping filamentous network that formed a denser structure with an increased number of small cavities for water retention (Figure 1d–1e). Sensory evaluation revealed that irrespective of the sodium chloride and/or sodium phosphate content, the sensory characteristics of beef gels were improved by HHP treatment at 150–200 MPa, compared to the unpressurized beef gels. Pressurized beef gels received high scores for the "Juiciness," "Easy to swallow," "Cohesiveness," "Springiness," and "Pleasant tasty" items ($P < 0.05$). HHP treatment at 150

MPa significantly increased the cohesiveness and springiness (elasticity) while decreasing the softness in the low-salt and/or low-phosphate beef gels ($P < 0.05$). The panelists reported that the texture of pressurized beef gels was firmer, more elastic, and more pleasant to bite. The total free amino acid content (Asp, Thr, Ser, Glu, Gln, Gly, Ala, Val, Met, Ile, Leu, Trp, Phe, His, Lys, Arg) in low-salt and low-phosphate beef gels increased after HHP treatment at 150–200 MPa, compared to non-pressurized beef gels ($P < 0.05$).

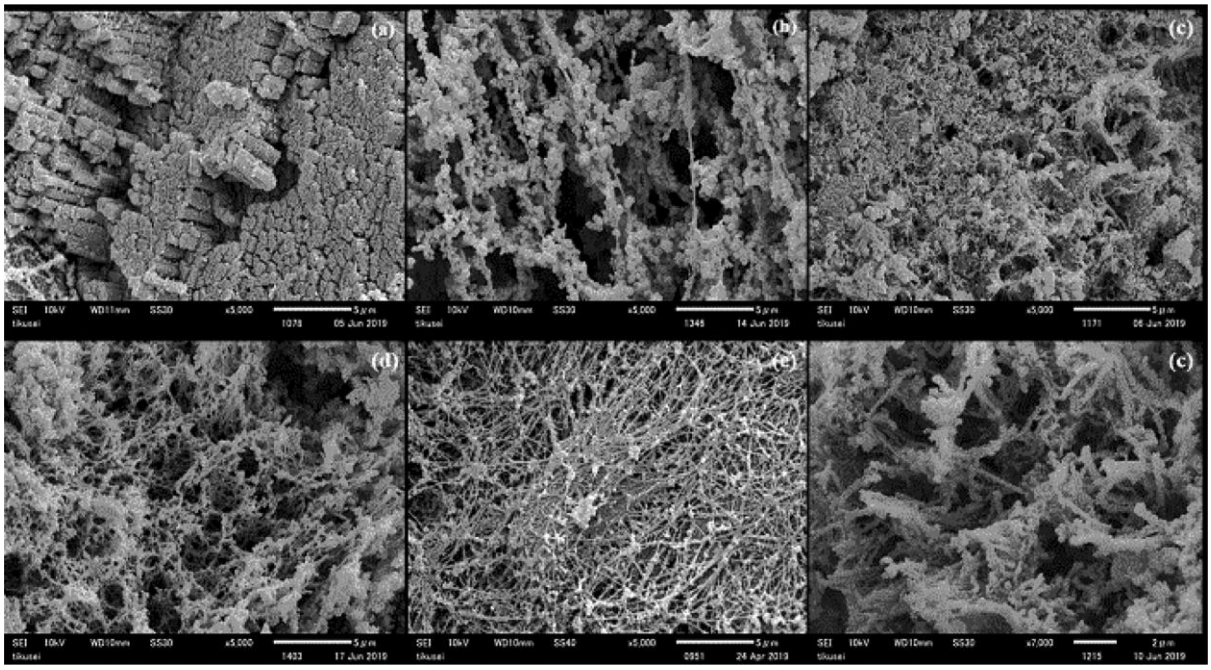

Figure 1.

SEM of gel microstructure. (a) beef gel, 0% NaCl/SPP, 0.1 MPa; (b) beef gel, 0% NaCl/SPP, 150 MPa; (c) beef gel, 2% NaCl + 0.5% SPP, 0.1 MPa; (d) beef gel, 1% NaCl + 0.5% SPP, 150 MPa; (e) beef gel, 1% NaCl, 150 MPa.

IV. CONCLUSION

These results were consistent with the results of the physicochemical parameters in our previous study and showed that HHP treatment of 150 MPa for 10 min and low-salt concentration in combination allowed us to produce low-salt and/or low-phosphate meat gels with superior textural and organoleptic properties.

Keywords: high hydrostatic pressure, low-phosphate meat products, low-salt meat products, myofibrillar proteins