

Optimization of high pressure processing conditions of beef gels with different salt additions using the response surface methodology

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Objectives: Optimization techniques provide a parameter change for determining optimum process conditions while keep other parameters stable. The primary advantage of this technique is that decreasing the number of experimental studies required to evaluate multiple parameters and their interactions. The response surface methodology (RSM) is a widely used mathematical and statistical method for modeling and analyzing a process in which the response of interest is affected by various variables and the objective of this method is to optimize the response.

It's a well-known information that high sodium consumption and insufficient potassium intake can be cause some health problems and also, high pressure (HP) technology can use for producing low salt products. Since high pressure technology is a new technology, it is important to determine the best production conditions. Referring all these, the aim of this study is investigating simultaneously the effect of the addition of NaCl and sodium pyrophosphate (SPP), pressure level and temperature on properties of beef gels using Response Surface Methodology.

Materials and Methods: In this study, RSM 4-factor, 3-level, Box-Behnken design with 3 replicates at the center point used as an experimental design and 4 different conditions experimented; high pressure treatment at 100-300 MPa, at the temperature of 4-36°C, concentration of 0-2% NaCl and 0-0.5% SPP. Minced beef used as sample and after adding different concentrations of salts according to output of the RSM program conditions, treated with high pressure in line with design. After performing analyses, results were processed by using RSM and got the 3D graphs.

Results and Discussion: Results of color examined based on CIELab Color Scale and ΔE calculated for observing the difference among samples. a^* values after HP had a maximum point about at 20°C, but other factors was not significant. b^* values after HP decreased with increasing of both of the salts concentrations but SPP was not significant. Also, minimum point about at 200 MPa and maximum point about at 12°C observed. L^* values after HP, there was a minimum point about at 175 MPa, 16°C, 0.25% SPP and 1.5% NaCl. ΔE values had maximum point about at 225 MPa and 0.38% SPP, minimum point about at 13.5°C but both of the salts affect was insignificant.

Results of pH after high pressure increased with increasing high pressure levels and decreased with the increasing temperature, there was a maximum point for SPP about at 0.25% concentration and NaCl did not really effected the pH. For pH values of after cooking, there was a minimum point at 200 MPa and 20°C but only SPP had significant effect and increased with increasing concentration.

Cooking loss is the degree of shrinkage of meat during cooking. The total loss that occurs during the cooking of meat includes the losses known as drippings and the volatile losses. The greater part of the volatile loss is from evaporation of water. Cooking loss had a minimum point about at 200 MPa but it was not significant. Temperature did not really had affect. With the increasing both of the salts concentration cooking loss decreased especially with increasing concentration of NaCl.

Breaking stress results had maximum point about 20°C and minimum point about 225 at MPa, 1% NaCl and 0.25% SPP. Elasticity results had maximum point about 0.3% SPP and also, minimum point about at 28°C, 250 MPa and 0.75% NaCl, but the effect both of the salts was not significant. Hardness increased with SPP and also, had maximum point about at 16°C, 250 MPa and 1% NaCl, but among them just the effect of HP was significant. Cohesiveness increased with HP treatment and, there was a minimum point about at 12°C, 0.25% SPP and 1.5% NaCl. Just temperature significantly affected cohesiveness.

HP treatment, treatment temperature, NaCl and SPP has effect on meat gels properties and can improves the meat quality. So, it is important that determining best conditions for the getting the best results. Thus, with this study we will be able to get closer to produce better quality beef gel products.

Key words: High pressure, Response surface methodology, Beef gel, Optimization, Low salt meat products