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Effects of High Pressure Treatments and Added Binders on the Physico-Chemical Properties of Restructured Pork Meat

Geun-Pyo Hong · Sung-Hee Park · Jee-Yeon Kim and Sang-Gi Min

Department of Food Science and Biotechnology of Animal Resources, Konkuk University

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 may be achieved through the formation of gels that set thermally (hot-set) or chemically (cold-set). Proteins derived from a variety of plant and animal resources have potential value as binders in restructured meat products. In addition, pressure is able to affect the protein structure, at the secondary, tertiary and quaternary levels, leading in general to protein denaturation (Lullien-Pellerin and Balny, 2002), andthe interactions between myofibrillar proteins can be also greatly influenced by applying HP to muscle (Macfarlane et al., 1984). In this respect, the application of high pressure (HP) in restructuring of meatcould be considered to prefer the palatable binding properties. Therefore, objective of this study was to compare the effect of HPon physicochemical and binding properties of restructured pork meat.

Materials and Methods

1. Materials and Treatment

Porcine *M. longisimus dorsi* was trimmed of visible fat and connective tissue and then ground through an 8 mm plate. Ground pork was mixed with 10 g/kg salt and 3 g/kg sodium tripolyphosphate, 20 g/kg binder and 200 g/kg water, and filled in fibrous casing. Four binders included isolated soy protein (ISP), sodium caseinate (SC), whey protein concentrate (WPC) and egg white powder (EW), respectively. High pressure treatments were performed in vessel manufactured by ourselves as described in our previous study (Hong et al., 2005). The compression fluid was ethyleneglycol and pressurization was carried out for 30 min under ambient temperature. Subjected pressure levels were 100 and 200 MPa, respectively. After pressurization, all samples were cooked at 50℃ for 60 min.

2. pH Measurement

pH measurements were carried out with a pH meter (Model 440, Corning, Schiphol-Rijk,

the Netherlands) on 5 g of sample mixed with 20 mL of water and homogenized at 13,000 rpm for 1 min.

3. Color Measurement

Color measurements were taken with Color meter (JC801S, Color Techno System Co. Ltd., Tokyo, Japan) calibrated with a white standard plate (X = 97.83, Y = 81.58, Z = 91.51).

4. Binding Strength

The force required to penetrate 10 mm restructured pork slices with a 9 mm diameter brass probe was determined using a digital gauge (DPS-20, IMADA Co., Toyohashi, Japan) and expressed as binding strength.

5. Water Binding Properties

Product yields were determinedby weight differences between before and after thermal processing. Moisture content was measured by 105℃ air drying method. Water holding capacity (WHC) was determined by the modified method of Pietrasik and Shand (2004). Cooking loss was determined by assessing the value of exudation after cooking at 75℃ for 30 min.

6. Statistical Analysis

The data were analyzed by ANOVA using the SAS statistical program, and differences among the means were compared using Duncan's Multiple Range test.

Results and Discussion

1. pH and Color

The pH values of all treatments were increased significantly ($P<0.05$) by HP(Figure 1A). This is probably associated with the denaturation of some protein fraction and possibly due to a decrease in available acidic groups in meat, as a result of conformational changesin myofibrillar protein (Tsai et al., 1998), although the mechanism of protein denaturation differs between thermal processing and HPprocessing, and agreed with our previous study (Park et al., 2005). In color measurements, L^*-value (Figure 1B) of all treatments increased significantly ($P<0.05$) probably due to globin denaturation or to hemedisplacement or release, while a^* (Figure 1C) and b^*-value (Figure 1D)of all treatment showed a significant decrease ($P<0.05$) with increasing pressure level. In comparison among treatments, the addition of binders could contribute additive effects on pH

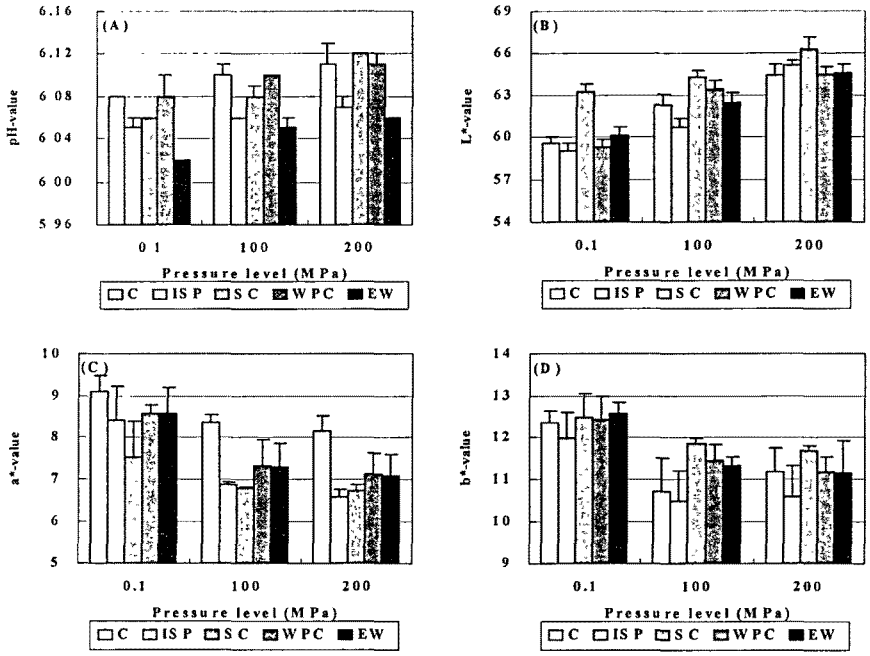

Fig. 1. Effects of high pressure treatments and added binders on (A) pH and (b) L^*-value, (C) a^*-value and (D) b^*-value of restructured pork.

and color of samples.

2. Water Binding Properties

HP treatment caused significant decrease ($P< 0.05$) in product yield (Figure 2A) and showed a slightly moisture loss (Figure 2B) possibly dueto holding time in pressure vessel for 30 min. In contrast, HP treatments had higher WHC than non-pressurized treatments (Figure 2C). This result can be explained that HP processing, causing pressure-induced disaggregation and unfolding of protein, leading to improvement of WHC. Non-pressurized samples had significantly higher cooking loss ($P<0.05$) than HP treated samples (Figure 2D). Among treatments, the addition of binders showed an improvement in both WHC and cooking loss at atmospheric pressure. However, no significant differences ($P>0.05$) among treatments were found at 200 MPa, whereas ISP and EW showed lower cooking loss at 200 MPa than other treatment. In consequence, the addition of non-meat protein had no effect in water binding capacity under HP, probably due to protein aggregation or to increase in surface hydrophobicity.

3. Binding Strength

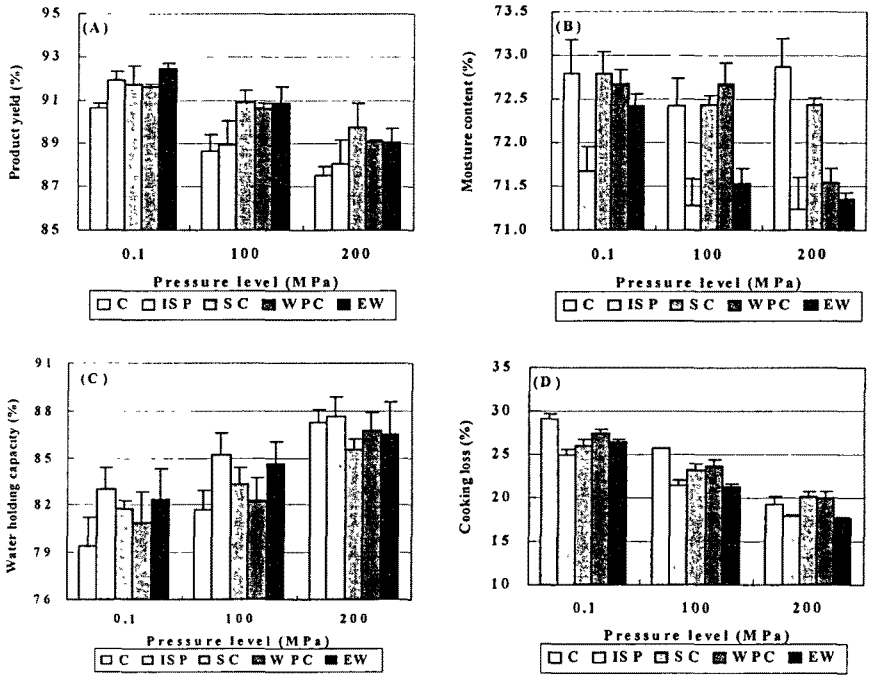

Figure 2. Effects of high pressure treatments and added binders on (A) product yield, (B) moisture content, (C) water holding capacity and (D) cooking loss of restructured pork.

The binding strengths of all treatment increasedsignificantly ($P<0.05$) with increasing pressure level (Table 1). With the comparison in binders, WPC had significantly lower binding strength ($P<0.05$) than C at atmospheric pressure. Binding strength of all treatments, however, increased gradually and significantly higher ($P<0.05$) in all treatments added binders at 200 MPa than C. ISP was the best binding agent in this study. The result indicated that the application of HP up to 200 MPa conferred the palatable binding properties on restructured meat products and that the addition of binders had synergistic effect such as other meat products.

Summary

In general, the application of HP contributes to improvement of functionalities of meat protein. In the current study, HP allowed the lower thermal processing of restructured meat product. Low thermal processing allowed fresh-like meat color which is one of problems in hot-set restructuring, while they showed slight discolorization induced by HP. In addition, HP processing combined with thermal processing could be achieved the palatable binding strength in restructured meat product. The addition of non-meat protein

Table 1. Effect of high pressure treatments and added binders on binding strength[1)] of restructured pork

Treatment[2)]	Binding strength (N)		
	0.1 MPa	100 MPa	200 MPa
C	3.75 ± 0.54^{Bc}	6.98 ± 1.06^{Bb}	8.59 ± 1.18^{Ca}
ISP	4.88 ± 0.64^{Ac}	9.41 ± 1.29^{Ab}	11.49 ± 1.05^{Aa}
SC	4.61 ± 0.49^{Ac}	6.99 ± 0.75^{Bb}	10.24 ± 1.39^{Ba}
WPC	2.80 ± 0.37^{Cc}	7.64 ± 1.19^{Bb}	10.65 ± 0.81^{ABa}
EW	3.60 ± 0.58^{Bc}	8.83 ± 0.90^{Ab}	10.14 ± 1.10^{Ba}

1) MeanS.D. of three replicate.
2) C, control; ISP, isolated soy protein; SC, sodium caseinate; WPC, whey protein concentrate; EW, egg white powder.
a~c Means with different letters within the same raw are significantly different ($p<0.05$).
A~C Means with different letters within the same column are significantly different ($p<0.05$).

had an effect in binding strength. However, they showed no effect on water binding properties at 200 MPa, especially in milk proteins such as casein and whey protein. This is probably due to protein aggregation or to increase in surface hydrophobicity under HP. This result indicates that the application of HP on meat restructuring is more significant than the addition of binders. Therefore,the application of HP has apotential benefit in restructured meat product, and further investigations are needed.

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