EVALUATION OF FUNCTIONAL PROPERTIES OF BINDERS CONSTITUTED WITH PIG PLASMA, SODIUM CASINATE AND SOYBEAN PROTEIN AND THOSE APPLICATION IN RESTRUCTURED PORK STEAK

D C. Liu[1]*, C. P Lin[1], and J. H. Liu[1]

[1]Department of Animal Science, National Chung Hsing University, 250 Kao Kung Rd Taichung 40227, Taiwan ROC

*Corresponding author (phone: +886-4-22872622; fax: +886-4-22860265; e-mail: dcliu@ dragon.nchu.edu.tw)

Abstract—The purpose of this study was to evaluate rheological properties and binding ability of four binders constituted with non meat proteins includes pig plasma(PP), sodium casinate(SC), and soybean protein(SP) and sorted as following (A) binder: 80PP+10SP+10SC, (B) binder: 60PP+20SP+20SC, (C) binder: 40PP+30SP+30SC, and (D) binder: 20PP+10SP+10SC, individually. The polymer formation and viscoelastic changes were evaluated by SDS-PAGE electrophoresis and dynamic rheological measurement, respectively. The four binders were applied to restructured pork and the appearance, textural properties, tensile strength, cooking loss and sensory panel test were evaluated in this research.

The results showed the polymer formation of the binders (A, B, C, and D) were performed by SDS-PAGE electrophoresis in figure 1. There were polymers on the top in SDS-PAGE for four binders with pig plasma, soy protein and sodium casinate and with the amount of soy protein and sodium casinate , polymers are more thicker and significant. After treated at 37℃ for one hour, polymers are observably clear and thick compared with non heating. In rheological properties, tangent delta (δ) value of binder A and B became smaller(< 1) after heating at 77℃ and the value rapidly decreased to 0.2 with heating temperature increasing. Besides, binder C and D need a higher heating temperature about 82℃ to form gel due to higher % of soy protein and sodium casinate in constitutes then tangent delta (δ) value gradually declined with heating temperature.

The crude protein and ash content of restructured pork steaks with four binders were significantly higher than those of the control (P<0.05). Moisture, crude fat, pH and cooking loss were not significantly different among four binders and the control. The color (L, a and b)of the restructured pork steaks with four binders and the control also were not significantly different in this study . In the textural properties , the hardness, fracturability, chewiness and shear value of restructured pork steaks with four binders were significantly lower than those of the control. However, The binding ability of restructured pork steaks with binder A and B had higher value compared with binder C, D and control. In sensory panel items, binding ability, flavor, juiciness and texture scores of restructured pork steaks with binder B had better score in all treatments and the control.

In conclusion, the better quality and binding ability of low salt restructured pork steak could be prepared by binder B constituted with 60PP+20SC+20SP in this research.

Key words: binder, pig plasma, sodium casinate, and soybean protein

I. INTRODUCTION

Binders are always used in restructured meat processing for improving the texture, slicing ability and binding of low salt meat products and reducing the cost. Pig plasma exists transglutaminase and can format a cross linkage (acyl-transfer reaction) on ε-(γ-glutamyl)lysine between proteins (Ikura, 1988), resulted in modifying protein and enhanced the binding ability for meat food (Kuraishi *et al*., 1997；Motoki and Seguro, 1998). Keeton *et al*. (1984), Mittal and Usborne (1985)and Matulis *et al*. (1995) indicated that high level soy protein can improve the texture and the hardness of frank sausage but had high score in off-flavor and resulted in lower acceptance for juiciness and palatability. Since sodium casinate has good water holding capacity, emulsfying capacity and better heating stability and also has better color and flavor in final products, usually used in ground meat products to improve the quality (Hoven, 1987；Sheng *et al.*,1992). However, few scientific research to study a complex binder with the three non meat proteins. The purpose of this study , thus, was to conduct polymer formation and viscoelastic property of myosin and four binders constituted with non meat proteins. Moreover, these binders were also applied to restructured pork steak and the appearance, textural properties, tensile strength, cooking loss and sensory panel test were determined to evaluate the actual functional ability in meat processing.

II. MATERIALS AND METHODS

Pig plasma, sodium casinate and soy protein were purchased from local additive company and their crude protein is 72.6% for pig plasma , 84.48% for sodium casinate and 77.44 % for soy protein, individually. Four binders were designed to constitute with pig plasma(PP), sodium casinate(SC), and soybean protein(SP) and sorted as following (A) binder: 80PP+10SP+10SC, (B) binder: 60PP+20SP+20SC, (C) binder: 40PP+30SP+30SC, and (D) binder:

20PP+10SP+10SC, individually. Each 5 mg no meat protein was added into 1 mL enzyme denature solution and mixing then incubated at 37℃ for 1 hr. After incubation, the mixture need be heated at 95℃ for 5 min then performed by SDS PAGE electrophoreses to understand polymer formation. The solution samples (2% protein, w/v) were prepared as the method of Hines and Allen (1993) for viscoelastic properties test and will be done by rheological instrument (Rheolograph-Sol No.653, Toyoseiki, Japan) in this study.

Prok ham was ground with 3/4 inch plate and mixed with 10% ice, 0.5% salt, 0.05% polyphosphates and 2% binder at 4 ℃ in vaccum tumber for 4 hr, stuffed into pork steak model container. Then put into 4 ℃ refrigerator for 12 hrs and frozen at -20℃ 24 hr. The restructured samples were re-tempered to -5-6 ℃ and then sliced (thickness : 2.0 cm) by a slice machine. Chemical content and pH of restructured pork steaks were determined according to AOAC (1990)' s method. Rheological properties of cooked restructured pork steaks also were performed by Sun Rheo Meter (Model Compac-100, Sun Rheo Meter, Japan) according to the steps of Pietrasil and Shand (2003). SAS (2003) 's GLM program was used to analysis all data in this study.

III. RESULTS AND DISCUSSION

The results showed the polymer formation of the binders (A, B, C, and D) were performed by SDS-PAGE electrophoresis in figure 1. There were polymers on the top in SDS-PAGE for four binders with pig plasma, soy protein and sodium casinate and with the amount of soy protein and sodium casinate , polymers are more thicker and significant. After treated at 37℃ for one hour, polymers are observably clear and thick compared with non heating. This phenomenon resulted from a cross linkage reaction of transglutaminase (TGase) from pig plasma with sodium casinate, and soybean protein. Kurth and Rogers (1984) and Nonaka et al.(1992) also concluded that casinate is a good substrate and a ε-(γ-Glu)Lys linkage can be formatted by TGase from plasma due to the structure of soy protein is similar to fibrinogen. Besides, TGase also can format a cross bridge with 7 S and 11S of soy protein Motoki and Nio, 1983；Motoki et al.,1984；Kurth and Rogers, 1984；Akamittath and Ball, 1992；Kim et al., 1993.).

In viscoelastic properties, storage modulus (G') indicates the elasticity and loss modulus (G'')is viscosity. The ratio of storage modulus/loss modulus is tangent delta (δ). The sample exhibits stronger elasticity if tangent delta (δ) value is < 1, conversely , the viscosity is higher and the texture is sol while tangent delta (δ) value is >1. In our research, figure 2 (I, II) showed tangent delta (δ) value of binder A and B became smaller(< 1) after heating at 77℃ and the value rapidly decreased to 0.2 with heating temperature increasing. Besides, binder C and D need a higher heating temperature about 82℃ to form gel due to higher % of soy protein and sodium casinate in constitutes and tangent delta (δ) value gradually declined to 0.3-0.4 with heating temperature.

The chemical composition of restructured pork steaks were showed as table 1, the crude protein and ash content of restructured pork steaks with four binders were significantly higher than those of control (P<0.05). Moisture, crude fat, pH and cooking loss were not significantly different among four binders and control. The color (L, and a)of the restructured pork steaks with four binders and the control also were not significantly different in this study (table 1). In the textural properties (table 3), the hardness, fracturability, chewiness and shear value of restructured pork steaks with four binders were significantly lower than those of control. However, The binding ability of restructured pork steaks with binder A and B had higher value compared with binder C, D and control.

In sensory panel items (table 2), binding ability, flavor, juiciness and texture scores of restructured pork steaks with binder B had better score compared with the other binders and control.

IV. CONCLUSION

In conclusion, the better quality and binding ability of low salt restructured pork steak could be prepared by binder B constituted with 60PP+20SC+20SP in this research.

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Table1 Effects of different binders on chemical content, pH, cooking loss, shear force and color of restructured pork steaks

Items	Control	binder A	binder B	binder C	binder D
Moisture%	73.80±1.41a	73.30±0.72a	72.90±1.82a	72.80±0.91a	73.00±1.13a
Crude Fat%	4.21±0.54a	3.46±0.37a	3.58±0.73a	4.08±0.45a	3.79±0.48a
Crude Protein%	17.60±0.49a	20.00±1.28a	19.00±1.62a	20.30±1.34a	20.10±1.07a
Ash%	1.67±0.05a	1.81±0.06a	1.76±0.18a	1.88±0.22a	1.82±0.08a
pH	6.20±0.10a	6.20±0.16a	6.20±0.18a	6.30±0.14a	6.40±0.14a
Cooking loss %	30.20±0.84[a]	28.80±1.92[a]	28.60±1.82[a]	29.00±1.58[a]	30.20±1.86[a]
Shear strength (g/mm^2)	1330.00±107.00[a]	1331.00±101.00[a]	1304.00±151.00[a]	1257.00±256.00[b]	1256.00±285.00[b]
L	36.86±1.85a	36.34±3.59a	35.54±1.76a	35.38±2.11a	34.50±2.12a
a	14.55±2.42a	13.11±2.18a	12.05±2.24a	11.84±1.82a	14.49±2.46a

Mean±S.D., n = 9.

Control = no additive, A= 80% PP, 10% SP, 10% SC; B= 60% PP, 20% SP, 20% SC;
C= 40% PP, 20% SP, 20% SC; D= 20% PP, 40% SP, 40% SC.

[a] Means within the same row with different superscripts are significantly different ($P < 0.05$).

Table 2 Effects of different binders on sensory panel items of restructured pork steaks

Items	Control	binder A	binder B	binder C	binder D
Appearance	4.8±0.79a	4.9±0.32a	4.8±0.32a	4.5±0.42a	4.4±0.52a
Binding	4.6±0.52a	4.8±0.42a	4.5±0.53a	3.8±0.63b	3.4±0.75b
Flavor	4.5±0.71a	4.5±0.53a	4.4±0.52a	4.0±0.11b	4.0±0.65b
Juiciness	4.3±0.48a	4.2±0.42a	5.0±0.01a	4.2±0.42a	3.4±0.52b
Texture	4.4±0.52a	4.2±0.42a	4.5±0.53a	4.0±0.47ab	3.5±0.53b
Overall acceptance	4.6±0.52a	4.7±0.48a	4.7±0.42a	4.2±0.42a	4.2±0.42a

The same as table 1.

Table 3 Effects of different binders on rheological properties of restructured pork steaks

Items	Control	binder A	binder B	binder C	binder D
Hardness (N)	12.20±0.93[a]	13.60±0.77[a]	13.40±1.35[a]	11.70±2.52[a]	11.70±1.89[a]
Cohesiveness (+)	1.14±0.19[a]	1.23±0.19[a]	1.31±0.18[a]	1.06±0.15[a]	1.01±0.22[a]
Fracturability (N)	1.99±0.37[a]	2.10±0.22[a]	1.85±0.46[a]	1.79±0.51[a]	1.70±0.40[a]
Chewiness (N)	14.80±3.78[a]	14.80±3.75[a]	14.30±2.89[a]	13.10±3.00[a]	12.80±2.98[a]

The same as table1.

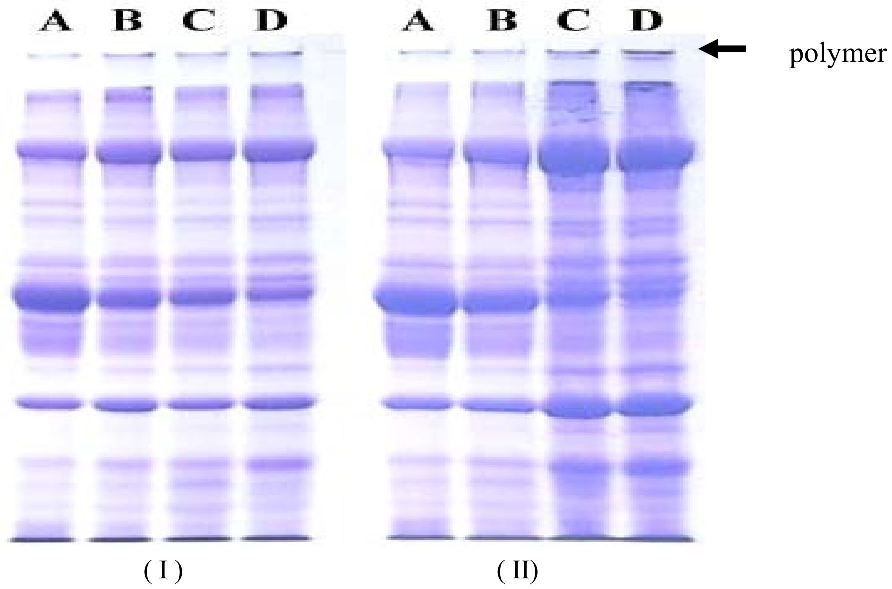

Figure 1 SDS-PAGE electrophoresis patterns of four binders constituted with pig plasma, soy protein and sodium casinate , (I) un-incubated and (II) incubated at 37℃ for one hour. Lane A- 80% PP, 10% SP, 10% SC; lane B- 60% PP, 20% SP, 20% SC; lane C- 40% PP, 30% SP, 30% SC; lane D- 20% PP, 40% SP, 40% SC.

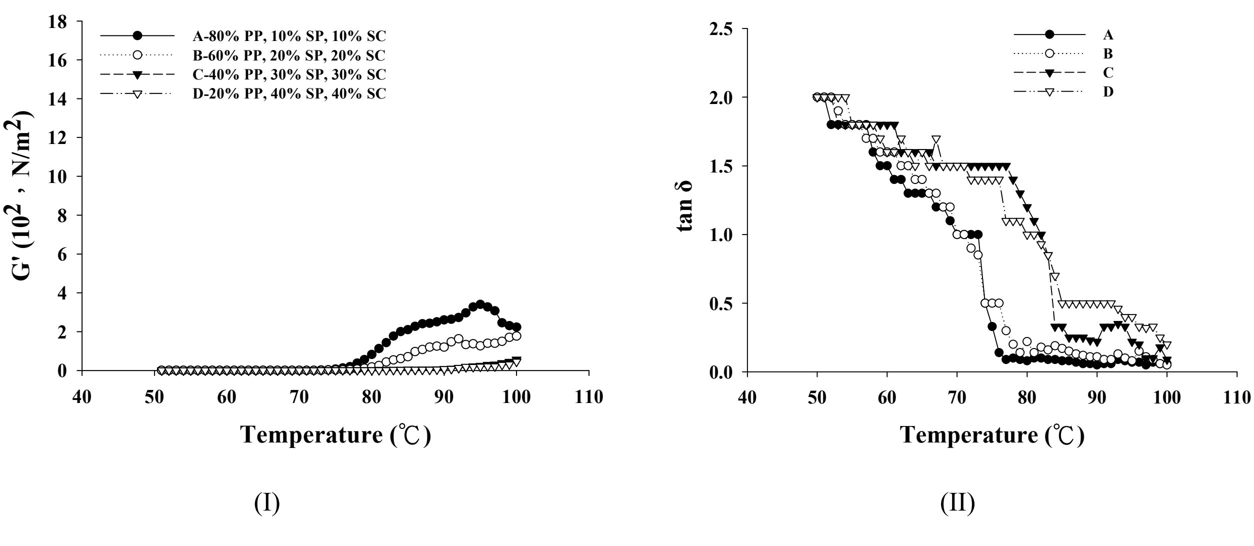

Figure 2 Changes in (I) storage modulus (G') and (II) tangent delta (δ) of four binders constituted with pig plasma, soy protein and sodium casinate heated from 50 to 100℃ by 1 ℃/min.