STUDY ON THE PHYSICOCHEMICAL PROPERTIES AND MICROSTURE OF THE GEL FORMED BY SALT-SOLUBLE MUSCLE PROTEINS ADDED WITH HSIAN-TSAO GUM AT DIFFERENT LEVELS

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Abstract - The objective of this study was to determine the properties of the protein–polysaccharide interactions occurring in a gel formed by mixing hsian-tsao gum and salt-soluble muscle protein. Physicochemical properties and microstructure of the gel formed by salt-soluble muscle protein (SSMP) mixed with Hsian-tsao gum (HG) at different levels were investigated. Therefore, texture properties, water-holding capacity, chemical interaction and microstructure of the gel were determined. The results showed that the hardness, chewiness and springiness of the gels were the highest in the gel which contained 0.15% HG, and it also could provide excellent colour and water holding capacity. By contrast, the microstructure and changes of chemical interactions in the process of heat-induced gel with 0% and 0.15% HG, we found that hydrophobic interactions, disulfide bonds and non-disulfide bonds were the main chemical interactions to maintain the stable structure of heat-induced gel, and the addition of 0.15% HG enhanced the main protein conformation to maintain the structure of the gel and improved the gel strength.

Key words - Hsian-tsao, Muscle protein, Protein-polysaccharide interaction

I. INTRODUCTION

Hsian-tsao (*Mesona procunbens* Hemsl) is one of the edible plants which contai polysaccharide gums. It has several healthy benefits such as lowering blood pressure and diuretic effect to make it quite popular in the areas of south China and Taiwan [1]. It has been reported that hsian-tsao gum can interact with starch synergistically, and results in a marked increase in viscosity and a formation of a thermo-reversible gel. Properties of hsian-tsao gum and starch have been investigated in aqueous model systems [2], but few studies have been reported about muscle protein and hsian-tsao gum interactions. The objective of this study was to determine the properties of the protein–polysaccharide interactions occurring in a gel formed by mixing hsian-tsao gum and salt-soluble muscle protein. The goal was to use the findings of this study to develop the functional muscle food by adding hsian-tsao gum as a binder.

II. MATERIALS AND METHODS

Materials

Hsian-tsao leaf was purchased from the Guan-Xi Farmers' Association, Hsing-Chu County, Taiwan. Porcine *longissimus dorsi* muscle was purchased from a local market.

Extraction of hsian-tsao gum (HG): The hsian-tsao leaf was ground and sieved by a 60 mesh screen, then cooked in 0.14 mol/L

$NaHCO_3$ at a ratio of 1:20 for 3 h, then filtrated through a 200 meshes gauze. The extracting solution was precipitated with 70% ethanol, centrifuged (2000g, 20 min) and vacuum-dried (40 °C, 48 h), pulverized, sieved (100 mesh), sealed in zip plastic bags, and then kept in a desiccator for analysis [1].

Preparation of muscle proteins: Salt-soluble muscle protein (SSMP) was prepared according to the procedures of DeFreitas, Sebranek, Olson, and Carr (1997b) with a slight modification and all preparation steps were carried out at 2-4℃ [3]. The protein concentration was determined by the method of biuret reaction [4].

Preparation of SSMP-HG sols

SSMP solutions were diluted to 2% protein with an isolation buffer as the protein extracts. HG powder was added to SSMP extracts to make SSMP-HG sols at 0, 0.05, 0.1, 0.15，0.2%, separately. All SSMP-HG sols were stirred and homogenized for 30s at medium speed using a blender. The cold-set sols were kept overnight at 4°C prior to rheology measurement [5].

SSMP-HG gels preparation

The SSMP-HG sols were centrifuged at 800 ×g for 15 min at 4°C to remove air bubbles and then transferred to sealed round boxes (diameter = 20 mm). Samples were equilibrated at 20°C for 10 min in a water bath, respectively heated to 50, 60，70 and 80°C at 1°C/min and held at final temperatures for 5 min. After heating, the gels were removed, placed in an ice bath and kept overnight at 4°C [6].

Methods

Gel water-holding capacity

Gel water-holding capacity was measured as the percentage of supernatant liquid after centrifugation of the gel at 3,000g (4°C) for 10 min. WHC(%)=[1-(ML/CG)] * 100%. ML is the weight of the moisture loss from the gel after centrifugation and CG is the weight of the cooked gel [7].

The textural properties of the gel was measured by a texture analyzer (TA-XT2i, Stable Micro Systems, Surrey, England) [8].

Gels solubility and chemical properties were determined according to the methods described by Matsumoto (1995) and Careche et al. (1980). Gels were treated with some certain chemicals that selected for their capacity to cleave the certain kinds of bonds and proteins partially solubilized for determining the existence of nonspecific associations, ionic bonds, hydrogen bonds, hydrophobic interactions and disulfide bonds [9-10].

The scanning electron microscope (SEM) model XL30 scanning microscope (PHILIPS, Holland) was used to investigate the structural characteristics of the developed cold-set gels [11].

III. RESULTS AND DISCUSSION

Table 1．The changes of texture properties of gel formed by SSMP added with HG at different levels

	The Levels of HG	Hardness (g)	Chewiness	Springiness
TPA of SSMP-HG gels	Control	279.08±3.28	158.10±3.39	82.99±0.22
	0.05%	296.99±3.67	171.07±7.99	84.98±0.75
	0.1%	318.38±4.23	196.61±3.75	86.01±0.34
	0.15%	350.86±9.19	211.67±1.19	87.40±0.97
	0.2%	308.79±1.54	190.23±3.14	85.18±0.72
	0.25%	297.64±6.45	174.32±3.39	84.88±0.56
	0.5%	123.29±3.10	41.64±1.93	77.64±1.29

Table 1 shows that hardness and chewiness of the gels were initially increased from 0.05% to 0.15%, then decreased with the increasing concentration of hsian-tsao extracts ($p<0.01$). And the water holding capacity of the gels did not change remarkably from 0.05 to 0.15% of addition of HG, and then dropped from 0.20%. These results indicated that the addition of HG at 0.15% was a proper usage to form a good SSMP gel.

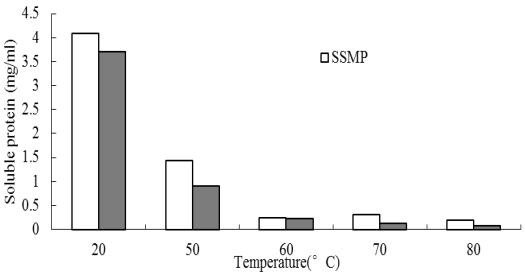


Fig 1. Effect of HG on static interactions during gel formation

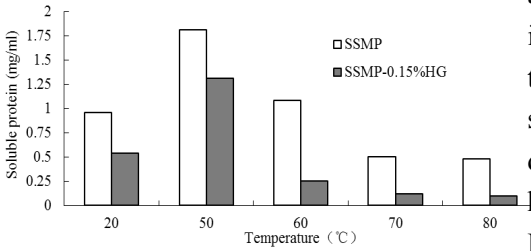


Fig 2. Effect of HG on hydrogen bonds during gel formation

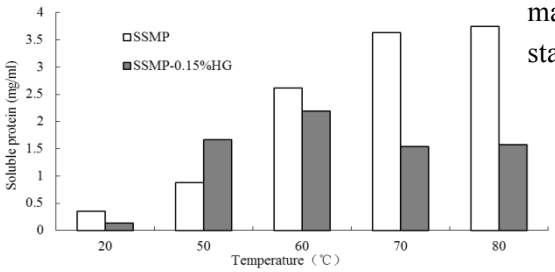


Fig 3. Effect of HTE on hydrophobic interactions during gel formation

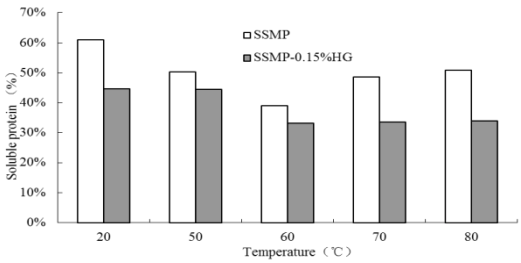


Fig 4. Effect of HTE on non-disulfide bond during gel formation

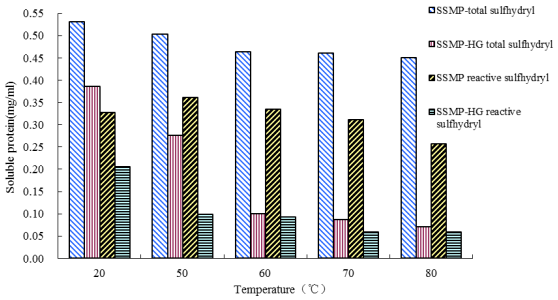
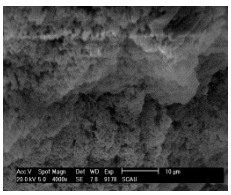
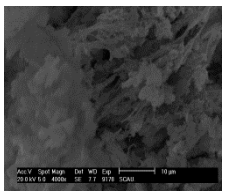


Fig 5. Effect of HG on total sulfhydryl and reactive sulfhydryl groups during gel formation

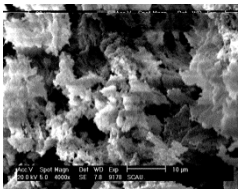
Electrostatic interactions, hydrogen bonding and hydrophobic interactions play an important role in maintaining the stability of the protein gel three-dimensional network structure. From Fig 2 to 6 we observed that during the gel formation，ion bonds and hydrogen bonds decreased significantly. However, hydrophobic interactions, disulfide bonds and non- disulfide covalent bonds increased markedly，which were the main chemical interactions maintaining the stable structure of gels.



P1



P2



P3

Fig 7. SEM of adding HTE or food binders to salt soluble protein from PLD

P1:The control（only SSMP), P2:SSMP + 0.15% HG, and P3: SSMP + 0.5% HG.

From Fig 7, we found that the microstructure of the gel from SSMP with 0.15% HG showed much denser than the control and SSMP with 0.50% of HG. Thus, it indicated that the addition of Hsian-Tsao gum could not over than 0.15% by weight of the SSMP. If added more than this limit it might compete with proteins to bind water to break the protein gel.

IV. CONCLUSION

From these results, it could be concluded that the proper adding amount of Hsian-Tsao gum could improve the functional properties of salt soluble muscle protein to form a gel. The Hsian-Tsao gum could also increase ~~in~~ non-disulfide bonds and disulfide bonds to improve gel strength.

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