# EFFECT OF HIGH PRESSURE PRETREATMENT ON THERMAL GELATION OF MYOFIBRILLAR PROTEINS AND SOYBEAN PROTEIN ISOLATE

Y. Wang[1], X.S. Zhu, G.H. Zhou*, Y.L. Yang , and C.B. Li

*Key Lab of Meat Processing and Quality Control, Ministry of Education, Nanjing Agricultural University, Nanjing,Jiangsu 210095, China*

**Key Words:** High pressure pretreatment, thermal gelation, rheological properties, gel structure

## Introduction

It is well known pressures can induce modification of the tertiary structure of proteins, characterized by modification of hydrogen bonds and disruption of hydrophobic bonds, resulting in modified reactivity of proteins (Chapleau 2003, Ikeuchi 1992). In gel of mixed proteins, addition of NaCl (2-3%) improved denaturation temperature of the soybean proteins isolate (SPI) (Scilingo and Anon 1996; Nagano and others 1996), limited its interaction with muscle proteins. However, few works describe the impact of pressure pretreatment on gelation of the mixed protein.

In this paper, we have investigated the effect of high pressure on the gel ability of mixed proteins using dynamic rheological measurements and scanning electron microscopy methods. Functional properties of mixture of MPI and SPI played an important role in meat products. Therefore the knowledge of gelation prosperity changes under pressure pretreatment may help for the further application in meat processing.

## Materials and Methods

*High pressure pretreatment* Myofibrillar protein isolate (MPI) was prepared from the chicken (breast) muscles. Protein content in soybean proteins isolate(SPI) is 88.7% (Sungreen Co., China).The mixtures of MPI and SPI in a 0.6M NaCl (1:1 ratios, protein 4%, pH 6.0) were vacuum-sealed in double flexible polyethylene bags and put into vessel which was filled with Dioctyl Sebacate. Then, the sample solution was exposed to the appropriate pressure (100, 200, 400, 600 MPa) for 20 min.

*Dynamic rheological Measurements* For the dynamic test, the samples were placed between 2 parallel plates (upper plate: 40 mm diameter) with 1 mm gap. Gelation was induced by heating the protein samples from 20 to 70℃ at aconstant rate (1.0℃/min). During heating, the samples were sheared at a fixed frequency of 100 mHz with a maximum strain of 0.02. Storage modulus, G' (the elastic component of the gel), was constantly recorded.

*Scanning Electron Microscopy* The unpressurized mixed protein were heated from 20 to 70℃ at aconstant rate (1.0℃/min) and the pressurized sample were heated at 55℃ for 20 min to form gel. Then the gels were cut into 1-2 mm cubes and fixed with 3% glutaraldehyde. After dehydration in a graded series of ethanol solutions, the specimens were transferred into 2-methyl-2-propanol, freeze-dried, coated with gold and observed in a scanning electron microscope.

## Results and Discussion

*Rheological properties* The test showed that within the temperature range of the thermal scan (30-70℃ ), SPI did not form a gel (Figure 1), MPI alone started to gel at around 45℃; and the G' reached a peak at 51℃ before descending to a minimum at 55℃. And the G' value at 70℃ was 181.7 Pa. In the mixed protein systems, pressurized mixtures of MPI and SPI of 100 MPa produced stronger gels than unpressurized mixtures, G' at 70℃ is 192.1 Pa. The pressurized mixtures of 200, 400, 600 MPa showed worse condition. The addition of SPI led to the decrease in the gel-forming capability of MPI (Feng and Xiong, 2002). But the pretreatment of high pressure resulted in the change of gelling properties of mixed proteins. However, the excessively high pressure had a negative effect on gel-forming attributes of protein mixture in that the elasticity decreased significantly during heating process. High pressure surpass 200MPa inhibitted protein to form gel (Iwasaki and others, 2006). But, this study showed that the pressure over 100MPa had a negative effect on the formation of protein gel. The difference between these studies may result from the difference in the concentration of salt solution (Suzuki and Macfarlane, 1984; Yasui and others, 1982).

*Gel structure* The addition of SPI made the heat-induced MPI's network non-uniform (Fig. 2-a). High pressure before heating improved the gel structure (Fig. 2-b). For heat-induced gel, it is required to heat up slowly for extending the protein molecules exposing more interior sulphydryl to accelerate the formation of disulfide bond and thus the formation of the gel network structure. The microscopy showed that the treatment of 100 MPa

[1] **Acknowledgements:** This work was performed under the financial support of programs: **2006CB708212** and **2006BAD05A03** from China's Ministry of Science and Technology.

and 55℃ resulted in a better gel network structure. This is because that pressure destroyed non-covalent bond, exposing the hydrophobic core of protein (Chapleau et al, 2003), accelerating the formation of gel during later heat processing, and SPI adopt a new structure reminiscent of the molten globule state.

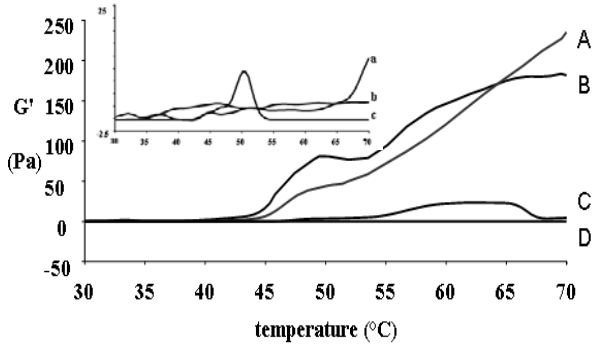


**Figure.1** Storage modulus (G') of the proteins in 0.6 M NaCl (pH 6.0), during gelation at different pressure (total protein 4%). Note: **A** MPI-SPI of 100MPa **B** MPI (protein 2%) **C** MPI-SPI **D** SPI.
Inset: Storage modulus (G') of mixed of proteins (protein 4%). Note: **a** 600 MPa, **b** 400 MPa, **c** 200 MPa

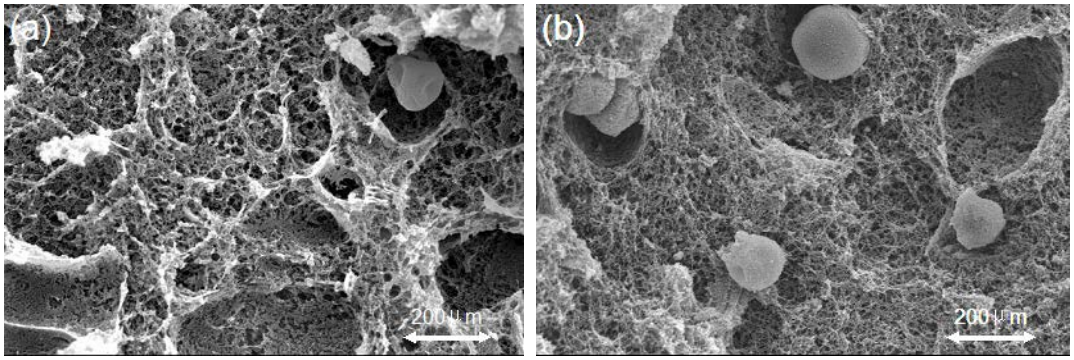


**Figure. 2** Scanning electron micrographs of pressure-heat-induced gel of MPI and SPI in 0.6 M NaCl (pH 6.0, protein 4%). **Note: a** unpressurized mixed protein gels ; **b** 100MPa pretreatment and then heated at 55℃ gels

**Conclusion**

Pressure pretreatment at 100 Mpa produced stronger gels of the mixed proteins of MPI and SPI than unpressurized mixtures, G' at 70℃ is 192.1 Pa. The micrographs also indicated that pressure pretreatment result in the change of structure of proteins and a more compact network formed.

The methods shortened the gel-forming time, reduced the destruction in the heat treatment, and supported a mild and exceptional processing method for gelation of mixed proteins. It could also be applied as a new tool to modify protein properties and consequently develop new food products.

**References**

1. Chapleau N., Mangavel C. and Compoint J.P., et al. (2003) Effect of high-pressure processing on myofibrillar protein structure. *Journal of the Science of Food and Agriculture*.84,66-742.
2. Feng J., Xiong Y.L. (2002). Interaction of myofibrillar and preheated soy proteins. *Food Science, 67*,2851-2856.
3. Ikeuchi Y., Tanji H. and Kim K., et al. (1992) Dynamic rheological measurements on heat-induced preassurized acromyosin gels. *Journal of agricultural chemistry*. 40,1751-1755
4. Iwasaki T., Noshiroya K. and Saitoh N., et al. (2006). Studies of the effect of hydrostatic pressure pretreatment on thermal gelation of chicken myofibrils and pork meat patty. *Food Chemistry, 95*, 474-483.
5. Nagano T., Fukuda Y. & Akasaka T. (1996). Dynamic viscoelastic study on the gelation properties of β-conglycinin-rich and glycinin-rich soybean protein isolate. *J. Agric. Food Chemistry, 44*, 3484-3488.
6. Scilingo A.A., Anon M.C.. (1996). Calorimetric study of soybean protein isolate: Effect of calcium and thermal treatments. *J. Agric. Food Chemistry, 44*, 3751-3756.
7. Suzuki T., Macfarlane J. J.. (1984). Modification of the heat-setting characteristics of myosin by pressure treatment. *Meat Science, 11*, 263-274.
8. Yasui T., Ishioroshi M. & Samejima K. (1982). Effect of actomyosin on heat-induced gelation of myosin. *Agricultural and Biological Chemistry. 46*, 1049-1059.