EVALUATION OF RHEOLOGICAL PROPERTIES OF PORK MYOFIBRILLAR PROTEIN GELS ADDED BY VARIOUS CONTENTS OF CORNSTARCH AND MICROBIAL TRANSGLUTAMINASE

Chang H. Lee and Koo B. Chin

Chonnam National University, Department of Animal Science

Gwangju, 61186, South Korea

*Corresponding author email: kbchin@chonnam.ac.kr

Abstract – The aim of study was to evaluate the rheological properties of myofibrillar protein gels as affected by various contents of cornstarch and microbial transglutaminase (MTGase). Cooking yield, gel strength, viscosity, SDS-PAGE and scanning electron microscopy (SEM) were measured to evaluate the rheological properties of myofibrillar protein gels. When the MTGase was added, all values were higher than the treatments without MTGase except for cooking yield, which were increasing with increasing the cornstarch contents. The results of gel strength were not significantly differences among treatments. Microstructure of cornstarch was swollen with water and its structure improved the cooking yield. Thus, cornstarch might be a water holding agent in meat gel system induced by MTGase.

Key Words – Rheological properties, Cornstarch, Myofibrillar protein gels, Transglutaminase

I. INTRODUCTION

Myofibrillar protein can be obtained from the pork muscle protein by extracted with high sodium solution. The functional properties of myofibrilllar protein, such as water binding capacity and gel strength, were highly associated with raw meat protein (Xiong, 1997). Transglutaminase is a enzyme that catalyze the crosslinking of glutamine-lysine in protein sequence (Folk, 1980). This reaction can enhance the textural properties on meat products. Starch, which has been added to meat products, is a popular ingredient not only for improving the functionality, such as water holding capacity, but also for reduced cost. Not many studies have performed the effects of various contents of starch on characteristics of low-fat meat products (Keeton, 1992). Thus, the objective of this study was to evaluate the rheological properties of myofibrillar protein gels added by various contents of cornstarch and microbial transglutaminase.

II. MATERIALS AND METHODS

Pork loin (Landrace x Yorkshire, grade A) was purchased from the local market (Samho Co., Gwangju, South Korea). All visible fat and connective tissues were trimmed out and made cubes. And then, myofibrillar protein was extracted from trimmed pork loin. Cornstarch was bought from the market (Cornstarch A^{+}, Tureban Co., South Korea). Microbial Transglutaminase (MTGase, Activa-TG 1% enzyme and 99% maltodextrin, 1 U/g activity) was provided by Ajinomoto Food Ingredients LLC (USA). Cooking yield, gel strength, viscosity, SDS-PAGE and SEM were measured. The statistical analysis was evaluated by two-way ANOVA method.

III. RESULTS AND DISCUSSION

Cooking yield and gel strength values are shown in Table 1. Since no interactions between the two factors (transglutaminase and treatments) were observed, data were pooled by transglutaminase or cornstarch levels ($p>0.05$). When MTGase was added to MP mixture, the cooking yields (%) were decreased, but gel strength values were increased (Table 1). The addition of cornstarch improved cooking yields, but not improved the gel strength. Increasing the cornstarch levels also increased the cooking yield, regardless of MTGase. These results indicated that the addition of cornstarch improved the water holding capacity, however didn't contribute the gel strength. However, the addition of cornstarch could hold more water than those without cornstarch even when the MTGase was incorporated into MP gels.

Table 1 Pooled means of myofibrillar protein with various contents of corn starch and microbial transglutaminase

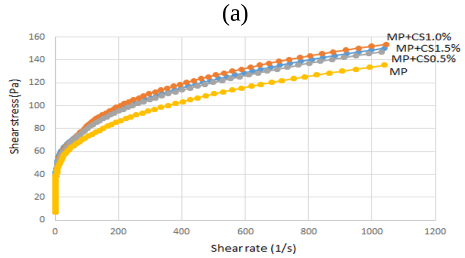
	Cooking yield	Gel strength				
Transglutminase * Treatments	NS	NS				
Transglutaminase	*	**				
Treatments	**	NS				
Parameters	Transglutaminase		Cornstarch level (%)			
	NTG	TG	0.0	0.5	1.0	1.5
Cooking yield (%)	82.6[a]	79.4[b]	75.5[c]	81.7[b]	82.6[ab]	84.1[a]
Gel strength (gf)	14.9[b]	140[a]	87.8	93.3	92.7	89.2

[a-c] Means with same superscript in a row are not different (p>0.05)

Viscosity results are shown in the Figure 1. Treatments with cornstarch were high viscosity than treatments without cornstarch. However, there is no differences in viscosity among various contents of cornstarch treatments (p>0.05), regardless of MTGase. Especially, 1.0% of cornstarch was highest viscosity among other treatments. And, treatments with MTGase showed high viscosity values compared to those without MTGase, indicating the highest gelling properties of those with MTGase upon cooking.

Figure 1. Viscosity of myofibrillar protein with various contents of cornstarch and transglutaminase (a) non-transglutaminase (b) transglutaminase

(a)



(b)

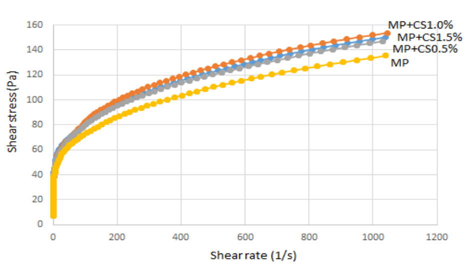
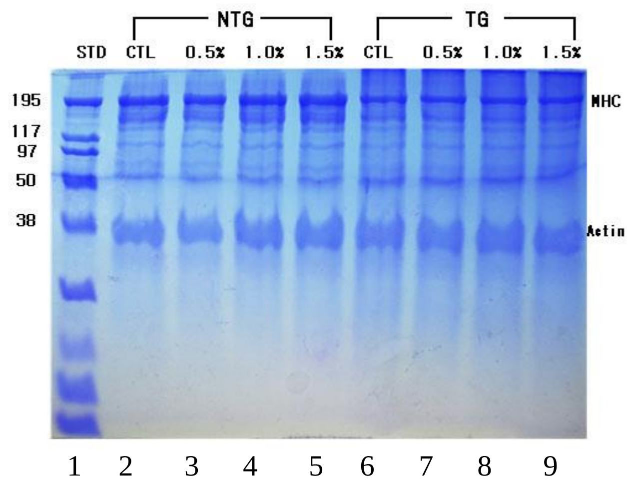


Figure 2 shows the SDS-PAGE results of myofibrillar protein with various levels of cornstarch with/without MTG. The high molecular biopolymer above the 195 KDa are shown. When 1% microbial TG was added, the myosin heavy chain (MHC) became disappeared. However, the addition or increased levels of cornstarch (CS) didn't change the protein bands in SDS-pAGE, resulting in no differences among all treatments in protein bands.

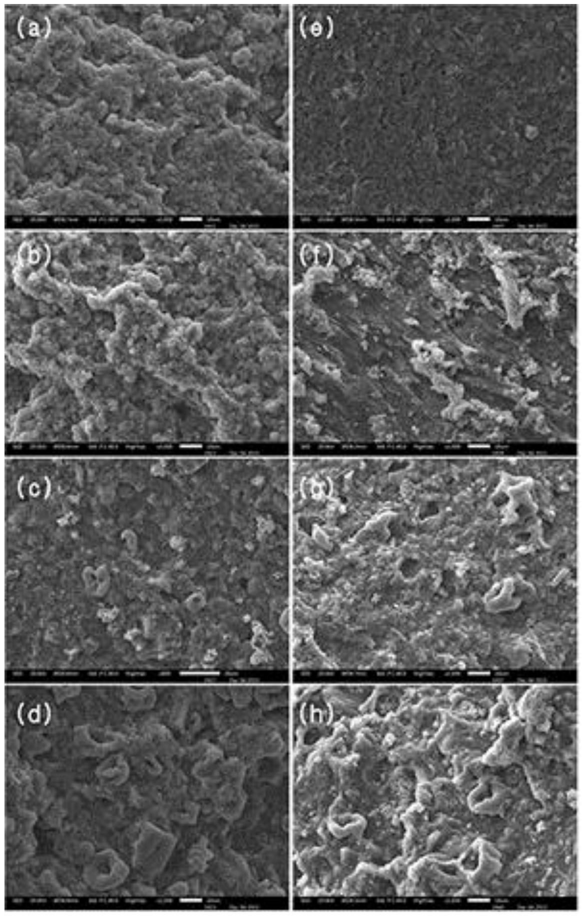
Figure 2. SDS-PAGE of myofibrillar protein with various contents of cornstarch and transglutaminase



1= standard marker, 2=CTL, no MTG; 3= 0.5% CS, no MTG; 4=1.0% no MTG; 5= 1.5% CD, no MTG; 6=CTL, 1% MTG; 7= 0.5% CS, 1% MTG; 8=1.0% CS, 1% MTG; 9= 1.5% CS, 1% MTG;

Figure 3 shows the microstructures of MP gels with cornstarch (CS) and MTGase, which induced MP gels (e, f, g, h) showed denser than those without MTGase (a, b, c, d). The reduced number of pores with increased cornstarch and MTG might improve the gel strength. The cornstarch might be inserted in the MP gels and, therefore increased levels of CS increased wet and smooth areas in MP gels. As a results, improved water holding capacity might be partially due to the swollen wet structure of protein matrix, which contribute to the good water holding capacity of MP gel system during cooking. This might be explained by the filling the pores in MP gels with cornstarch. These results also indicated that the addition of MTGase increased gel strength and the addition of CS improved WHC by reducing expressible moisture.

Figure 3. Microstructure of myofibrillar protein with various contents of cornstarch and transglutaminase



(a) Control without TG (b) CS 0.5% without TG (c) CS 1.0% without TG (d) CS 1.5% without TG (e) control with TG (f) CS 0.5% with TG (g) CS 1.0% with TG (h) CS 1.5% with TG

IV. CONCLUSION

MTGase (1%) improved the gel strength, and the addition or increased levels of cornstarch increased cooking yield. In addition, 1.0% of cornstarch might be optimum content to have maximal water holding capacity in MP gel system, regardless of MTGase. At the amount of cornstarch higher than 1.5%, the three dimentional structure were wet and smooth, resulting in the filling the pores of MP gels with cornstarch added. Thus, the better gelling characteristics as affected by environmental conditions, such as pH and salt concentrations, will be studied in near future to obtain the better information of those mixed meat gel system.

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REFERENCES

1. Folk, J. E. (1980). Transglutaminase. Annual Review of Biochemistry, 49, 517–531.
2. Keeton, J.T. 1992. Low-fat meat products – Technological problems with processing. Proceedings of38th International Congress of Meat Science and Technology, Vol 1, p. 175-182. Clermont-Ferrand. France.
3. Xiong, Y. L. (1997). Structure-function relationship of muscle protein. In S.Damodaran & A. Paraf (Eds.), Food proteins and their applications (pp. 341–392). New York: Marcel Dekker, Inc.