THE EFFECT OF OXIDATION ON TEXTURAL AND WATER HOLDING PROPERTIES OF MYOFIBRILLAR PROTEIN GEL AND ITS MECHANISM

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I. INTRODUCTION

This study was designed to investigate the influence of protein oxidation on the textural and water holding properties of myofibrillar protein（MP）gel, and to reveal the mechanism of gel properties changes with the degree of protein oxidation, in order to provide the theoretical basis for controlling the gel properties and the quality of chicken products.

II. MATERIALS AND METHODS

Live chickens were slaughtered. The breast muscle was stored in a refrigerator(-18℃) until MP was extracted. Effects of protein oxidation on the textural properties of MP gel were studied in the lipoxygenase-linoleic acid-MP system using a texture analyzer. Water holding capacity (WHC) of MP gel was measured by high-speed centrifuge. I760 and I850/I830 measured by Raman spectroscopy were used to represent the hydrophobic interaction and hydrogen bond of MP gel, and the potential value was determined by Zeta potential to reflect electrostatic repulsion. The formation of disulfide bond was determined by the change of total sulfhydryl group (SH). The ultrastructures of the gel were observed by scanning electron microscopy. The amino acid composition and content were investigated by an amino acid analyzer. The data were processed by SPSS17.0.

III. RESULTS AND DISCUSSION

The carbonyl content and the degree of oxidation of MP increased with increasing linoleic acid concentration in the lipoxygenase-linoleic acid-MP system. Hardness of the MP gel increased from 10.5 g to 12.95 g as linoleic acid concentration increased from 0 to 2 mM, and then decreased with the further increase of linoleic acid. Springiness changed slightly during 0-0.2 mM linoleic acid, and then decreased with more linoleic acid. At 2 mM linoleic acid, the WHC of MP samples obtained the max value. The network of the MP gel was dense, porous and uniform in pore size at 2 mM linoleic acid, and the gel pore size became larger and uneven at higher linoleic acid concentration. I760 reached the maximum at 2 mM with the increase of the degree of oxidation, and then decreased with the further increase of the degree of oxidation. The intramolecular hydrogen bonds could be formed by the three amino acid residues Ser, Glu and Cys, and the content of these three amino acids decreased with the increase of the degree of oxidation. Meanwhile, the I850 / I830 of the Raman spectrum increased with the increase of the degree of oxidation and finally> 1.25, indicating that the hydrogen bond between MP molecules decreased with the increase of the degree of oxidation. After dissociation, the content of negatively charged Glu decreased with the increase of the degree of oxidation, which led to the decrease of the absolute value of Zeta potential with the increase of the degree of oxidation, indicating that the electrostatic interaction decreased with the increase of the degree of oxidation. The sulfhydryl group of Cys could form disulfide bond in the gel formation process. The content of Cys decreased with the increase of the degree of oxidation, resulting in the change of the total sulfhydryl content in the same direction, which indicated the formation of disulfide bonds in the oxidation process. The total amount of hydrophobic amino acids (Ala, Met, Val, Leu, Ile and Phe) increased with increasing degree of oxidation and reached maximum at 2 mM linoleic acid, which provided evidence that hydrophobic forces reached their maximum at 2 mM. The principal component analysis suggested that hydrophobic interaction is the key force controlling the gel properties in the lipoxygenase-linoleic acid-MP system

IV. CONCLUSION

Moderate oxidation of MP helped to improve the properties of MP gels, and the gel hardness of MP reached the maximum at 2 mM in the lipoxygenase-linoleic acid-MP system. The mechanism is that oxidation changed the composition and hydrophobic interaction of MP. When the linoleic acid was 2 mM, the total amount of hydrophobic amino acid in MP molecule was the highest and the hydrophobic force was the largest, and the microstructure of the gel was uniform and dense. The texture and water retention of MP gel were the highest.

Key words: Myofibrillar protein; gel properties; oxidation; composition; forces; mechanism