OXIDATION-INDUCED STRUCTURAL CHANGES OF YAK MYOFIBRILLAR PROTEIN UNDER DIFFERENT PACKAGING CONDITIONS IN FROZEN STORAGE

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Abstract –The objectives of this study were to investigate the effects of packing conditions and duration of frozen storage on the oxidation-induced structural changes of myofibrillar protein extracted from *longissimus dorsi* and *biceps femoris* muscles of yak meat. The two type muscles were packaged in either ordinary or vacuum method. The myofibrillar proteins were extracted. Carbonyl and total sulfhydryl contents, solubility, surface hydrophobicity, molecular weights, and gel properties were analyzed during their 120-day frozen storage. The results showed that two packaging methods in frozen storage had a significant impact on protein oxidation ($p<0.05$). A relatively lower carbonyl and sulfhydryl contents, surface hydrophobicity, solubility, gel hardness and water-holding capacity (WHC) were observed in vacuum packaging samples. *Longissimus drosi* had lower carbonyl and sulfhydryl contents, surface hydrophobicity, gel hardness, springiness and WHC, while protein solubility and gel whiteness were higher than the corresponding *biceps femoris* groups($p<0.05$). These results suggested that protein in yak meat may be more susceptible to oxidation in freezing storage with ordinary package, and the protein functionalities were also influenced.

Key Words –Yak meat, protein oxidation, physico-chemical properties.

I. INTRODUCTION

Yak is a specific cattle species which dwells on the high altitude area in Tibetan Plateau. Yak meat has very different nutrients profile in comparison with other cattle species. Freezing is the most common method to preserve yak fresh meat so far. However, studies manifested that freezing seriously affects protein carbonyl content and meat quality, such as WHC, color and texture. Currently, however, there is almost no research information about the changes of yak meat in frozen storage, and especially no literatures about protein oxidation for frozen yak meat are available. In this study, protein oxidation-induced structure changes of yak myofibrillar protein in frozen storage were evaluated.

II. MATERIALS AND METHODS

Yak fresh meat muscles were obtained from a local slaughterhouse in Hongyuan county (China). Two types of yak muscle, *longissimus drosi* (LD) and *biceps femoris* (BF), were subjected to two different packaging methods, ordinary packaged (OP) and vacuum packaged (VP). The entire study included 4 treatments: LD with OP (LO), LD with VP (LV), BF with OP (BO) and BF with VP (BV). Muscle samples were immediately frozen and transferred to the laboratory after postriger (36-40 h postmortem), and were frozen at -18℃ for 120 days. Myofibrillar protein were extracted from samples at days 0, 30, 60, 90 and 120, and the carbonyl groups, total sulfhydryl content, Surface hydrophobicity, SDS-PAGE, and protein solubility were analyzed. Heat-induced gel of myofibrillar protein was prepared. Texture characteristics, WHC, Whiteness value were evaluated for the gels. All data were from triplicated samples and were analyzed using the statistical package SPSS 21 for one-way ANOVA.

III. RESULTS AND DISCUSSION

Protein carbonyl content in yak meat tended to increase on day 30, but the magnitude of increase was significant only by day 60 ($P < 0.05$). Carbonyl content of VP indicated no significant increase ($P> 0.05$) on day 90, while differences were found in OP. LR samples tended to decrease but BR samples significantly increased ($P < 0.05$). The carbonyl contents of all the four samples decreased significantly ($P < 0.05$) by day 120. The carbonyl content in OP samples was 1.27-fold higher than that in VP samples on day 60, 1.34-fold on day 90 and 1.39-fold on day 120. All carbonyl contents in OP and in VP of LD were less than in the BF treatments, and this may infer that BF muscle oxidative sensitivity is higher than the LD. Total sulfhydryl groups in all of the four treatments increased significantly ($P <0.05$) on the day 60 and a downward trend was observed at day 90 and 120. Sulfhydryl groups in LD were less than that in BF($P>0.05$), and were higher in OP than in VP. Surface hydrophobicity in all treatments

showed an increasing trend at the storage time of day 30, suggesting that after stored for 30 days, the structure of myofibrillar protein tended to unfold and more residual hydrophobic amino acids exposed [1]. Surface hydrophobicity in BF displayed a significant increase ($P < 0.05$) by day 30, but not in the LD ($P > 0.05$). At day 90, surface hydrophobicity of OP groups revealed an increasing trend in comparison to VP groups and continued to decrease to day 120. A significantly higher value than the other three treatments was observed in BO after stored for 30 days. SDS-PAGE results discovered that the electrophoretogram had decreasing intensities in myosin and actinin bands, which confirmed that myofibrillar proteins, especially myosin, were particularly sensitive to oxidation. This decrease was especially obvious in BO, which coincides well with the sharp elevation in carbonyl formation. Reduction in the band intensity of actin (45 kDa), troponin and tropomyosin (36 kDa) was observed and actin (100 kDa) band turned light, and disappeared during day 60 to 90. No new band generated by fragmentation of myofibrils has been detected. It is reasoned that LD and VP undergone less extent of oxidation than BF and OP under the same condition.

Solubility of myofibrillar protein increased in 30 days of frozen storage, indicating a minor enhancement in protein solubility by moderate oxidation. Since the 30 days, a continuous decreasing was observed in the four treatments during the prolonged storage. Protein solubility in LD increased significantly ($P <0.05$) by day 30 and decreased significantly in the following days, while there's no significant changes ($P> 0.05$) in BF groups throughout the storage period. The lower solubility was observed in VP samples, especially in LV groups. After 120 days of frozen storage, solubility of proteins from LR and BR was decreased to 35.24% and 39.60%, respectively, in comparing to 28.637% and 30.075% in LV and BV.

Hardness of myofibrillar protein gel increased by up to 70% ($P < 0.05$) after moderate oxidization within 30 days, and followed by a rapid decline. Similar phenomenon was also confirmed by Xiong et al. [2]. The gel hardness during frozen storage was in descending order of BO>LO>BV>LV, showing higher gel hardness in BF and OP. WHC of myofibrillar protein gels continuously decreased with the extension of storage time. Significantly decrease in VP groups was observed after 30 days of storage. The gel whiteness of yak myofibrillar protein showed a rising trend during the whole storage time after stored for 120 d. The lowest gel whiteness was observed in BR samples, and whiteness values of BV samples were lower than LD corresponding groups (i.e. LV). VP groups have the higher whiteness value than OP samples. These indicated that LV and VP retarded protein denaturation.

IV. CONCLUSION

Vacuum packaging can effectively reduce the oxidation of myofibrillar proteins during frozen storage of yak meat, but it could not block the changes of physical and chemical properties and gel properties. The *biceps femoris* muscle had more serious oxidation, and myofibrillar protein showed better gel properties than *longissimus drosi*, indicating moderate oxidation can improve their gelling properties.

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