EFFECT OF MYOGLOBIN PHOSPHORYLATION ON MEAT COLOR STABILITY

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Abstract – Phosphorylation of myoglobin in postmortem muscles was investigated in relationship to color stability in the present study. Although no difference was observed in global phosphorylation level of sarcoplasmic proteins, difference was determined in phosphorylation levels of individual protein bands from muscles with different color stability. Especially the phosphorylation level of myoglobin band differed significantly among different color stability groups at 24 h postmortem. As the phosphorylation of myoglobin increased, color stability based on a^* value decreased. In summary, the study revealed that phosphorylation of myoglobin might play a role in regulation of meat color stability by regulating the redox stability of myoglobin.

Key Words –myoglobin, redox stability, sarcoplasmic proteins

I. INTRODUCTION

Meat color is the most intuitive basis for consumers to evaluate the meat quality, which influences the purchase decision to a large extent. Reversible phosphorylation is the most common post-translational modification of proteins, which regulates most aspects of cellular biological processes. Our previous study shows that meat color stability was inversely related to the global phosphorylation of sarcoplasmic proteins[1]. To better understand the biochemistry of meat color stability, protein phosphorylation was comparatively analyzed in muscles with different color stability in the present study.

II. MATERIALS AND METHODS

The longissimus thoracis et lumborum (LTL) muscles were removed from sixty Bayan nur sheep right after exsanguination, and stored at 4℃ for 8 days to simulate retail display. Sample was collected at 45 min, 6 h, 24 h, 3 d, 5 d, and 7 d postmortem(PM). Meat color (CIE-$L^*a^*b^*$) was measured at four random locations on each LTL muscle. R630/580 was calculated by the ratio of reflectance at 630 to 580 nm as an indicator of meat color stability. A larger ratio indicates greater redness contributed by either OxyMb and/or DeoxyMb and thus means greater color stability. Samples were ranked according to the a^* and R630/580 values on day 7. Fifteen carcasses were selected and divided into three groups (five in each): high color stability (high), moderate color stability (moderate) and low color stability (low). The sarcoplasmic proteins extraction and protein phosphorylation level determination were performed as previously described with some modifications [2]. Statistical analysis was carried out with the IBM SPSS Statistic 21.0 software (SPSS Inc., Chicago, IL, USA). All data are presented as mean ± standard deviation (n = 5).

III. RESULTS AND DISCUSSION

3.1 Meat color attributes of the three groups

The a^* values and R630/580 values are presented in Fig.1A and Fig.1B respectively. No significant difference ($P > 0.05$) was observed in a^* and R630/580 values within the first 24 h postmortem. The a^* and R630/580 values were higher ($P < 0.05$) in high color stability group than in low color stability group on day 3 postmortem. On day 5 and day 7, the $a^*$and R630/580 values were highest in the muscles from the high color stability group, lowest in the low color stability group and intermediate in the moderate color stability group. All this suggests that the grouping in this study can meet the needs of experimental design.

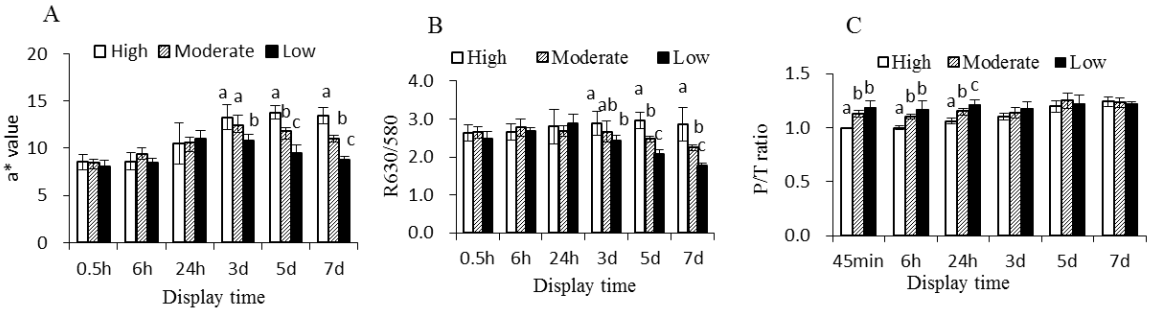

Fig. 1 a^* values, R630/580 values and the phosphorylation level of myoglobin in muscles with different color stability. (A) Changes of a^* values. (B) Changes of R630/580 values. (C) The phosphorylation level of myoglobin. Different letters at the same time mean significant difference between groups ($P < 0.05$).

3.2 The phosphorylation of myoglobin of the three groups

The phosphorylation level of myoglobin(Fig.1C) in the high color stability muscle was significantly lower ($P < 0.05$) than that in the low color stability group within the first 24 h PM. Although no difference in the phosphorylation level of myoglobin existed between the moderate and low color stability groups at 45 min and 6 h PM, higher ($P < 0.05$) phosphorylation level was detected in low color stability muscle at 24 h PM. The phosphorylation of myoglobin has been confirmed in our lab (unpublished). This result indicates that the phosphorylation level of myoglobin is inversely related to meat color stability. This is consistent with a previous study [3] which observed an acidic shift of isoelectric point (pI) of myoglobin on 2-DE gels. As a pI acidic shift is a symbol for phosphorylation of proteins with pI > 6.4 [4], the reported pI shift of myoglobin might be caused by phosphorylation, which leads to lower color stability [3]. As phosphorylation changes the structure and stability of proteins [5], it is likely that phosphorylation changed the structure of myoglobin and thus myoglobin became more susceptible to oxidation. A recent study has reported that human neuroglobin undergoes hypoxia-dependent phosphorylation [6] and it is possible that the difference in myoglobin phosphorylation between groups was contributed by the difference in oxygen availability. In summary, it can be speculated that myoglobin might be more susceptible to oxidation after phosphorylation, which might be one of the reasons why phosphorylation of myoglobin was correlated with meat color stability.

IV. CONCLUSION

In conclusion, the present study indicated that the phosphorylation of myoglobin might regulate its redox stability and thus influence meat color stability. However, the exact underlying mechanism needs investigation by further studies.

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