DYNAMIC CHANGES IN POST-MORTEM QUALITY OF MIRROR CARP (*CYPRINUS CARPIO L.*): BASED ON OXIDATION REACTION AND MITOCHONDRIAL IMPAIRMENT

Haijing Li[1], Xue Bai[1], and Xiufang Xia[1*]

[1] College of Food Science, Northeast Agricultural University, Harbin, Heilongjiang 150030, China

*Corresponding author email: xiaxiufang@neau.edu.cn

I. INTRODUCTION

The mirror carp (*Cyprinus carpio L.*) is one of the most important species of freshwater fish in northeastern China due to its fast growth and soft flesh. Nowadays, the sale of freshly pre-processed fish fillets has gradually substituted for the traditional sale of live fish, and consumers also tend to accept this sales method [1]. Given the degradation in the quality of the fish with time, large fluctuations in consumer acceptance are also expected. Therefore, it is necessary to study the physiological changes within the fish during the post-mortem storage and sale process to better assess the economic value of the fish. This study investigates the effect of post-mortem storage on the freshness of mirror carp from the perspective of oxidative reactions and mitochondrial impairment, aiming to provide theoretical support and technical guidance for post-mortem quality control of mirror carp.

II. MATERIALS AND METHODS

Live mirror carps (1000 ± 50 g) were purchased from the local market in Harbin. The transportation and handling of the fish were similar to that posited by Liu *et al.* [2] with slight modifications. The dorsal flesh was washed with pre-cooled deionized water and then cut into approximately 30 g cubes. The cubes were mixed, packed into 8 polyethylene bags, and stored at 4 °C for different lengths of time (0, 2, 4, 6, 12, 24, 48, and 72 h) before measuring. All measurements were done three times and each time in triplicate. Means were compared by the Duncan test using IBM SPSS Statistics 25 to determine that the difference was statistically significant ($P < 0.05$).

III. RESULTS AND DISCUSSION

As shown in Figure 1A, at 4 h post-mortem, the pH value reached a minimum (6.58), while the centrifugal loss reached a maximum (17.13%). The electrical conductivity of the mirror carp increased from 869 μS/cm at 0 h to 1400 μS/cm at 72 h post-mortem. From Figure 1B, total volatile base nitrogen (TVB-N), thiobarbituric acid reactive substances (TBARS), and carbonyl content all significantly increased with increasing post-mortem storage time ($P < 0.05$).

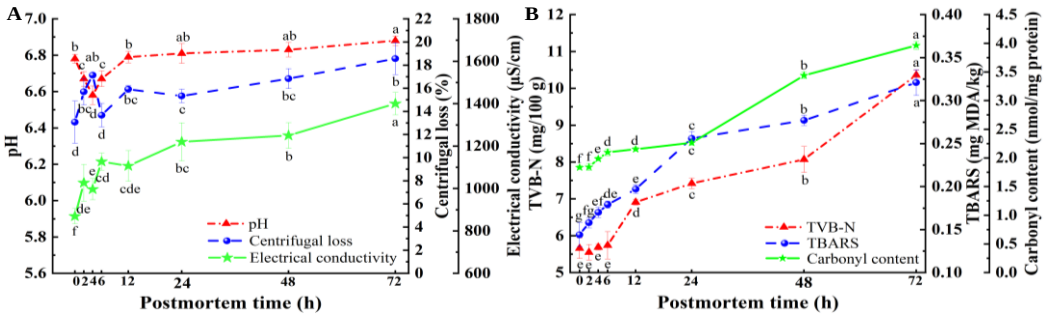

Figure 1. Changes in the pH, centrifugal loss, and electrical conductivity (A), TVB-N, TBARS, and carbonyl content (B) of the mirror carp during post-mortem storage.

The means in the same index with different lowercase letters (a-g) differ significantly (P < 0.05).

As displayed in Figure 2A, the reactive oxygen species (ROS) content in mitochondria significantly decreased at 0-2 h post-mortem, while it significantly increased at 2-72 h post-mortem (P < 0.05). The decrease in absorbance reflects the increase in mitochondrial membrane permeability transition pore (MPTP) opening [1]. The absorbance at 540 nm decreased within 72 h post-mortem, suggesting a significant increase in MPTP opening (P < 0.05) (Figure 2A). The mitochondrial membrane fluidity significantly decreased with increasing post-mortem storage time (P < 0.05).
Additionally, Zhang *et al.* [3] found that the absorbance at 520 nm exhibited an opposite trend to mitochondrial swelling. As seen in Figure 2B, the absorbance decreased within 72 h post-mortem, indicating the mitochondrial swelling increased. The level of cytochrome c (cyt-c) reduction in the mirror carp significantly decreased during post-mortem storage (P < 0.05), suggesting that the oxidation level of cyt-c increased during the aging process.

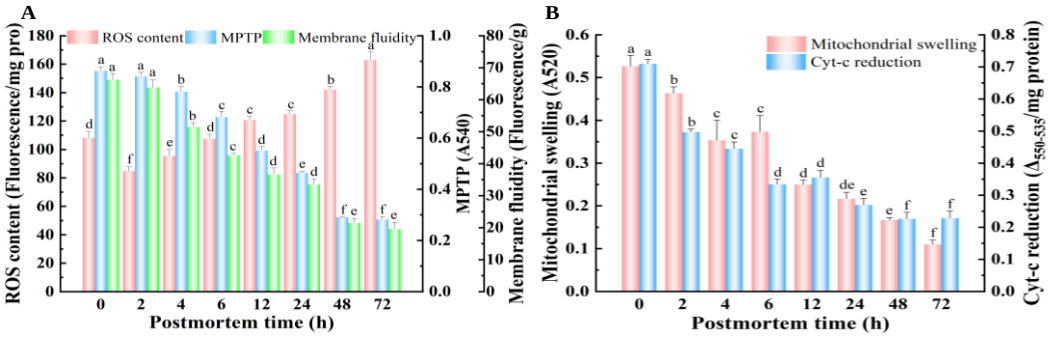

Figure 2. Changes in the ROS content, MPTP, and mitochondrial membrane fluidity (A), mitochondrial swelling, and cyt-c redox stability (B) of the mirror carp during post-mortem storage.
The means in the same index with different lowercase letters (a-f) differ significantly (P < 0.05).

IV. CONCLUSION

This study indicated that post-mortem storage deepened oxidation, reduced its freshness, and eventually led to a decrease in the quality of the mirror carp. Besides, with oxygen and energy deprivation after slaughter, the accumulation of ROS induced an increased MPTP opening and decreased mitochondrial membrane fluidity, leading to mitochondrial swelling and the release of cyt-c from mitochondria into the cytosol via the MPTP, which consequently leads to the apoptotic process. These findings provide a theoretical basis for further research on the quality control of freshwater fish during post-mortem storage.

ACKNOWLEDGEMENTS

Xiufang Xia thanks the National Natural Science Foundation of China (Grant No. 32172273).

REFERENCES

1. Tie, H. M., Dong, J. L., Jiang, Q. X., Yu, D. W., Yang, F., Xu, Y. S., & Xia, W. S. (2022). Profound changes of mitochondria during postmortem condition used as freshness indicator in grass carp (*Ctenopharyngodon idella*) muscle. Food Bioscience 48: 101749.
2. Liu, D. S., Liang, L., Xia, W. S., Regenstein, J. M., & Zhou, P. (2013). Biochemical and physical changes of grass carp (*Ctenopharyngodon idella*) fillets stored at -3 and 0 °C. Food Chemistry 140: 105-114.
3. Zhang, J. Y., Ma, G. Y., Guo, Z. B., Yu, Q. L., Han, L., Han, M. S., & Zhu, Y. M. (2018). Study on the apoptosis mediated by apoptosis-inducing-factor and influencing factors of bovine muscle during postmortem aging. Food Chemistry 266: 359-367.