THE EFFECT OF ELECTROSTATIC FIELD ASSISTED CONTROLLED FREEZING POINT STORAGE ON THE FRESHNESS OF BEEF

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I. INTRODUCTION

Beef is one of the main meat products in China and an important component of the human daily diet. It is deeply loved by consumers due to its rich nutrients, high protein, and low-fat characteristics. Controlled freezing point storage (CFPS), storing the meat from the freezing point of meat to 0ºC, has been proposed as a promising method to maintain the quality of fresh meat [1]. However, the narrow temperature range of CFPS makes it not suitable for large-scale applications in the industry. Therefore, many auxiliary technologies were proposed to improve the effectiveness of CFPS. Lots of research has proven that the electrostatic field (EF) could efficiently assist in freezing, thawing, and refrigerating to maintain the preservation quality of meat [2]. However, whether the EF could be introduced to CFPS and affect the freshness of beef has not been studied well. Therefore, exploring the effect of EF-CFPS on beef has become the subject of our interest.

II. MATERIALS AND METHODS

M. Longissimus thoracis et lumborum (LTL) muscles were procured from 6 carcasses (Simmental bull, 22-month-old, 400 kg live weight), stored at controlled freezing point storage, and randomly allocated to 2 treatment groups: the control group samples (CK) were treated with no electrostatic field; the electrostatic field group samples (EF) were treated with 3300~4000 V EF. Days 0, 7, 14, 21, 28, 35 were sampled for subsequent determination. The total viable count (TVC) and total volatile basic nitrogen (TVB-N) were measured. Statistical analyses were conducted using the general linear model program of IBM SPSS (version 26, USA). The T-test was used to identify the significance between the 2 treatment groups ($P < 0.05$) and the least significant differences test was used to identify the significance between different storage times ($P < 0.05$).

III. RESULTS AND DISCUSSION

As shown in Fig. 1A, the TVC of beef in each treatment group exhibited an increasing trend with the extension of storage time. On day 35, the TVC of beef exceeded 6 log (CFU/g), indicating that the beef had undergone spoilage. On days 14 and 21, the TVC of beef in the EF group was significantly lower than that in the CK group ($P < 0.05$), indicating that EF-CFPS has a certain inhibitory effect on the growth and reproduction of bacteria. It is possibly due to strong oxidizing substances such as ozone negative ions produced by EF were inhibited the growth and reproduction of bacteria to some extent [3,4]. As shown in Fig. 1B, the TVB-N of beef significantly increased with the extension of storage time ($P < 0.05$). On day 35, the TVB-N of beef in each treatment group exceeded 15 mg/100 g, indicating that the beef had deteriorated. The TVB-N of beef in the EF group was lower than that in the CK group ($P < 0.05$). This is mainly attributed to the EF delaying the denaturation of proteins, thus reducing the accumulation of basic nitrogen-containing substances such as ammonia and amines [5].

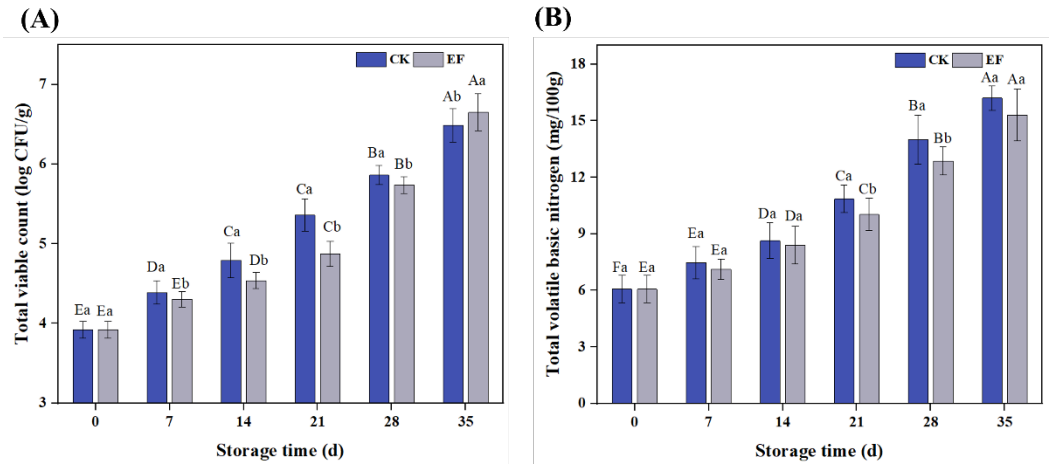

Figure 1. Effect of the EF-CFPS on the Freshness of Beef

A-E: Different letters represent the significance of TVC/TVB-N for the same treatment group at different storage days ($P < 0.05$). a-d: Different letters represent the significance of TVC/TVB-N for different treatment groups on the same storage day ($P < 0.05$). Abbreviations: CK: treated with no electrostatic field; EF: treated with 3300~4000 V electrostatic field. (A): TVC; (B): TVB-N.

IV. CONCLUSION

EF-CFPS could effectively inhibit the increase in TVC and TVB-N of beef. It could effectively delay quality deterioration and maintain the freshness of beef.

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REFERENCES

1. Li, X., Zhang, Y., Li, Z., Li, M., Liu, Y., & Zhang, D. (2017). The effect of temperature in the range of −0.8 to 4°C on lamb meat color stability. Meat Science, 134: 28-33.
2. Huang, H., Sun, W., Xiong, G., Shi, L., Jiao, C., Wu, W., Li, X., Qiao, Y., Liao, L., Ding, A.,& Wang, L. (2020). Effects of HVEF treatment on microbial communities and physicochemical properties of catfish fillets during chilled storage. LWT - Food Science and Technology, 131: 109667.
3. Hussain, M., Nauman, K., Asghar, B., Iqbal, S., & Rashid, M. A. (2021). Effect of low voltage electrical stimulation and chilling on microbial safety and quality attributes of Beetal Bucks and Lohi Rams carcass. Small Ruminant Research, 196: 106315.
4. Qi, M., Zhao, R., Liu, Q., Yan, H., Zhang, Y., Wang, S., & Yuan, Y. (2021). Antibacterial activity and mechanism of high voltage electrostatic field (HVEF) against *Staphylococcus aureus* in medium plates and food systems. Food Control, 120: 107566.
5. Qian, S., Li, X., Wang, H., Mehmood, W., Zhong, M., Zhang, C., & Blecker, C. (2019). Effects of low voltage electrostatic field thawing on the changes in physicochemical properties of myofibrillar proteins of bovine *Longissimus dorsi* muscle. Journal of Food Engineering, 261: 140-149.