COMBINATION OF ULTRASOUND TREATMENT AND STARTER CULTURE FOR IMPROVING THE QUALITY OF BEEF JERKY

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I. INTRODUCTION

Beef jerky is the most popular traditional dried and fermented meat product in China. However, the spontaneous fermentation of beef jerky is vulnerable to variable environmental conditions, which hinders the production of a uniform and high-quality product (e.g., flavour, colour, and texture profiles). In addition, traditional beef jerky has low water activity and moisture-to-protein ratio, resulting in a dry and firm product [1]. Therefore, this study aimed to investigate the effects of treatment by ultrasound (US), inoculation of *Pediococcus acidilactici* BP2 strain (BP), and their combination (US–BP) on the quality characteristics of beef jerky.

II. MATERIALS AND METHODS

Fermented beef jerky was prepared as Wen et al. [2] described. The beef strips were divided into four treatment groups (1 kg per treatment): a control treatment; ultrasound treatment (300 W at 30 kHz) (US), inoculation of *P. acidilactici* BP2 (BP); the combination of ultrasound treatment (300 W at 30 kHz) and inoculation of *P. acidilactici* BP2 (US–BP). The *P. acidilactici* BP2 inoculation level was 10^7 CFU/g of beef jerky. The low-field nuclear magnetic resonance (LF-NMR) was determined using the method of Luo *et al.* [3]. The scanning electron microscopy (SEM) and shear force were measured according to the method of Wang *et al.* [4] and Han *et al.* [5]. The volatile compounds and sensory analysis were measured as described by Hu *et al.* [6]. The data were analysed by the General Linear Models procedure of the Statistix 8.1 software package and the analysis of variance (ANOVA) was used in conjunction with Tukey's multiple comparison test to identify significant differences between samples ($P < 0.05$).

III. RESULTS AND DISCUSSION

As shown in Fig. 1 A, beef jerky treated by US–BP showed the lowest shear force value, followed by the US, BP, and control samples. Fig. 1 B contains visual depictions of the muscle fiber microstructure by SEM in beef jerky exposed to different treatments. The muscle fibers of the control and BP-treated samples were arranged tightly and orderly, in contrast to the disorganized and visibly loosened structural integrity of the muscle fibers after the ultrasound treatments, especially the US–BP treatment. These results can be explained by the cavitation effect of ultrasound and the role of lactic acid bacteria in hydrolysing muscle protein. This result is in concurrence with the above shear force results. The distribution and mobility of water molecules in beef jerky were analysed by measuring the relaxation time (T_2) based on LF-NMR. All samples had three separate peaks, including T_{2b}, T_{21}, and T_{22} (Fig. 1D), and the corresponding peak area proportions (P_{2b}, P_{21}, and P_{22}) were calculated (Fig. 1E). T_{2b}, T_{21}, and T_{22} were significantly delayed in the US and US–BP samples compared to the control sample ($P < 0.05$). Thus, ultrasound treatment caused relatively faster relaxation rates and resulted in more tightly bound water, immobilized water, and free water. the amplitude of P_{2b} was comparable between the beef jerky treated with US and US–BP ($P > 0.05$) and higher than the P_{2b} in the control and BP-treated samples ($P < 0.05$). The altered proportion of P_{2b} was mainly attributed to the denaturation and modification of protein. Fig. 1F showed that the heatmap clustered the four treatments into two groups (BP and control; US and US–BP) and US–BP could effectively improve the flavour of beef jerky. Sensory profile analysis of beef jerky is illustrated in Fig. 1C. The US–BP samples were perceived as having the highest colour intensity ($P < 0.05$). The juiciness of the US-treated sample and tenderness of the samples treated with US and US–BP were highest among all samples. Regarding the flavour of beef jerky, the samples treated with US

and US–BP showed higher taste scores than the other samples. The highest odour score among the samples was assigned to the beef jerky treated with US–BP ($P < 0.05$).

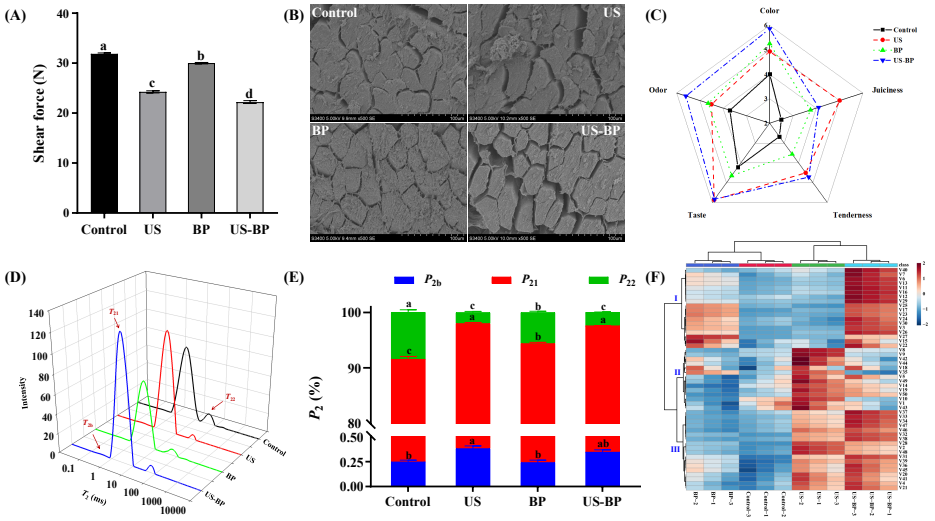

Figure1 Effects of different treatments on the shear force (A), scanning electron microscopy images (B), radar image of sensory analysis (C), distribution of the low-field nuclear magnetic resonance transverse relaxation times (T_2) (D), peak area proportions (P_2) (E), and the heatmap of volatile compounds (F) of beef jerky. Different letters (a-d) indicate significant differences ($P < 0.05$).

IV. CONCLUSION

These results indicated that the combination of ultrasound treatment and starter culture inoculation could be a potential technology to effectively improve the quality of beef jerky.

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