EFFECT OF SUB-FREEZING STORAGE (-6, -9 and -12°C) ON QUALITY AND SHELF LIFE OF BEEF

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I. INTRODUCTION

Conventional chilling, superchilling and freezing storage are common methods for the preservation of meat and meat products [1-3]. However, the shelf life of chilled meat at 4°C is only 1 week [4], which means the meat cannot be transported over long distances. Superchilling (1-2°C below the initial freezing point of the product [5]) requires strict temperature control. Freezing (-18 to -40°C) allows a shelf life of 18 months or more [6], but it consumes high amount of energy and temperature abuse occurs frequently. Furthermore, it takes long time in thawing which leads to inevitable deterioration in quality of meat during the process [7]. Compared with the temperatures discussed above, the range of -3 to -18°C is rarely studied.

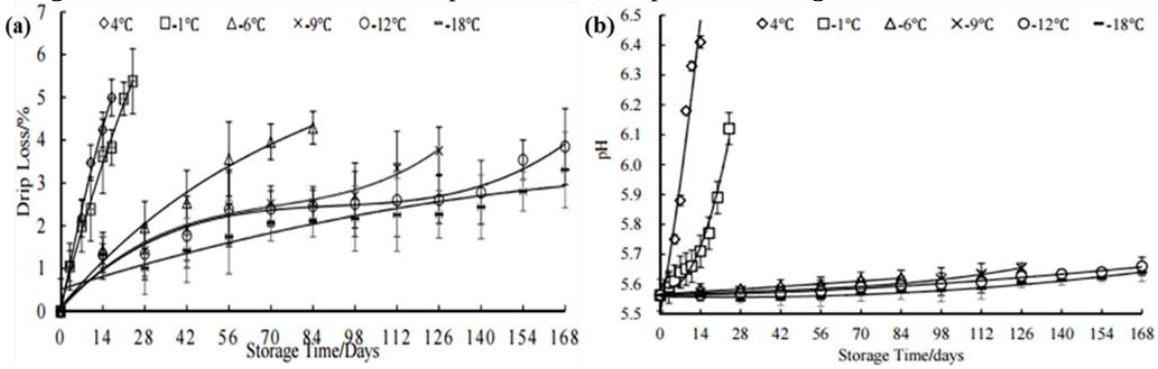
Based on the results of LF-NMR (the frozen state of -6, -9 and -12°C were nearly the same with extremely low free water content), -6, -9 and -12°C were designated as sub-freezing temperatures. The objectives of the present work were to investigate the effects of sub-freezing storage on the quality and shelf life of beef compared with conventional chilling, superchilling and conventional freezing storage.

II. MATERIALS AND METHODS

Samples of bovine *Longissimus dorsi* were obtained from a 2-year old bull weighing 400±5 kg (Simmental × Mongolian cattle, Mengdu Meat Co. Ltd., Inner Mongolia, China). Samples were cut into 50mm*50mm*50mm pieces after removing the visible fats, ligaments, bones and tendons. The samples under investigation were assigned randomly to six groups, including conventional chilling storage at 4°C, superchilling storage at -1°C, sub-freezing storage at -6°C, -9°C, -12°C and conventional freezing storage at -18°C (n= 6 samples from each storage temperature group). The refrigeration conditions were stable and each sample was held at its proper temperature throughout the duration of the storage period (168 days). After thawing (4°C), sensory properties, total volatile basic nitrogen (TVB-N), thiobarbituric acid reactive substances (TBARS), total viable counts (TVC), pH, color, shear force and drip loss were determined. Additionally, the samples were analyzed by an LF-NMR system when the central temperature of samples reached 4, -1, -6, -9, -12 and -18°C respectively. All experiments were carried out at least in triplicate and the values given below were the means of these triplicates. Statistical analyses were performed using SPSS version 19.0(SPSS Inc., Chicago, IL, USA). Significant differences were analysed using one-way ANOVA and Duncan's multiple-range test at a significance level of 0.05.

III. RESULTS AND DISCUSSION

The results of drip loss (Figure 1a), pH (Figure 1b), shear force (Figure 1c), TVB-N (Figure 1d), TBARS (Figure 1e) and TVC (Figure 1f) suggest that sub-freezing temperatures could effectively maintain the quality of beef during storage. The shelf life of beef was extended to 84 d and 126 d under -6°C and -9°C storage, respectively. It is worth mentioning that there were no significant differences (p>0.05) found between the indicators for quality and shelf life of samples stored at -12°C and -18°C throughout the storage period (168 days), demonstrating that storage at -12°C has similar effects on preservation compared to storage at -18°C.



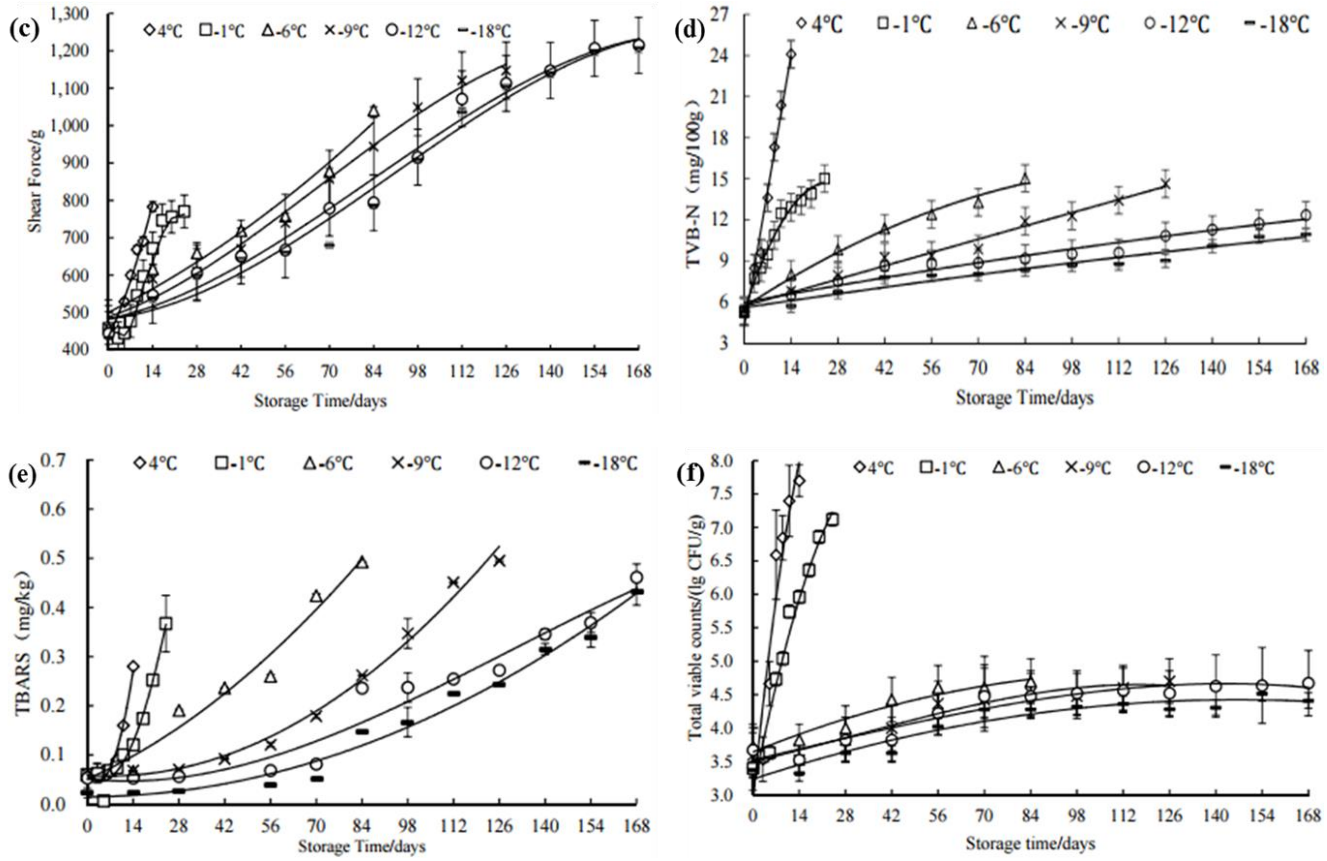


Figure 1. Changes in the drip loss (a), pH (b), shear force (c), TVB-N (d), TBARS (e) and TVC (f) of beef during storage at 4, -1, -6, -9,-12 and -18 °C.

IV. CONCLUSION

Our results will be particularly beneficial to the beef processing industry, which contributes to choose suitable conditions when freezing preservation is required for meat and meat products. A pilot scale experiment has already carried out in Mengdu Meat Co. Ltd. (Inner Mongolia, China) to verify this newly developed storage method and the preservation effect is under verifying. When beef is transported in a short distance and consumed quickly, choosing -6°C as the storage temperature is appropriate. This type of beef is convenient for factories to process using term “from frozen to fresh”. Storage at -9°C will be effective for beef required to be transported over longer distances. For the beef which demands long-term storage (up to 168 days), -12°C is more suitable for preservation compared to -18 °C (energy saving).

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