DOES A FREEZE-THAW CYCLE AFFECT THE QUALITY OF SOUS-VIDE BEEF?

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I. INTRODUCTION

Freezing is a well-established process widely recognized for extending the shelf-life of meat. Industrially, the utilization of frozen meat as a raw material has become prevalent in recent years due to various advantages such as the acquisition of a sufficient quantity of homogeneous batches, control of market prices, and consistency of the quality attributes [1]. Particularly for sous-vide products, freezing meat in proper portions suitable for sous-vide cooking increases their ease of use (it enables heating only a required number of meat pieces instead of heating more portions than needed). However, freezing might have an adverse effect on beef tenderness, juiciness and meat taste [2], it also increases cooking loss and decreases the lightness and redness of beef [3]. On the other hand, freezing has been observed to result in a decrease in WBSF in cooked meat [2,3]. However, there is a shortage of information about the influence of freezing on the quality of sous-vide beef products. Therefore, the present study aimed to investigate the influence of freezing on the quality of sous-vide beef steaks.

II. MATERIALS AND METHODS

The study was performed on *longissimus lumborum* muscles obtained from 8 Polish Holstein-Friesian bulls (slaughtered at the age of 23 months, 700 kg of live weight). From each muscle, two sub-samples were cut and vacuum-packed individually. All samples were aged to 14d post-mortem at 4°C. Next one sub-sample from each muscle was sous-vide cooked (4h at 60°C) and its quality was assessed. The remaining samples were frozen (-21°C) and kept frozen (-21°C) for 2 months and then thawed (at 7°C for 24h), sous-vide cooked and assessed. The following quality attributes were assessed: pH of raw meat [4], cross-section color of sous-vide cooked beef steaks in the CIELab color space [5], thaw and cooking losses [4], Warner-Bratzler Shear Force (WBSF) [4], Texture Profile Analysis using Instron 5942 universal testing machine (Instron, Norwood, USA) [6], and sensory quality including aroma intensity (1, imperceptible; 10, extremely intense), juiciness (1, extremely dry; 10, extremely juicy), tenderness (1, extremely tough; 10, extremely tender), and meat taste intensity (1, imperceptible; 10, extremely intense) [4]. Data were statistically analyzed in the Statistica 13.3 program (TIBCO Software Inc., Palo Alto, CA, USA) using the variance components module with freezing as a fixed factor (2 levels: unfrozen (control) beef and frozen-thawed beef) and a carcass as a random factor (8 repetitions). When analyzing the results of sensory evaluation also panelist was included in the model as a random factor.

III. RESULTS AND DISCUSSION

The average thaw loss in samples which were frozen after ageing was 6.6%. As a result of freezing the value of pH in raw meat increased from 5.5 to 5.6 ($P < 0.05$). There was no difference in cooking losses between samples processed directly after ageing and samples stored frozen (23.6% vs. 22.8%, respectively). Freezing and thawing affected the color of sous-vided cooked beef, which was

manifested in a significant increase ($P < 0.05$) in lightness, redness, yellowness, chroma and hue angle. Treatments showed similar values of WBSF (30.1 N and 33.0 N, for control and frozen samples). The values obtained indicate that sous-vide cooked beef samples were tender regardless of the storage method before cooking. However, freezing and thawing affected some texture attributes such as hardness 1, and hardness 2, which were higher in frozen-thawed samples, and cohesiveness, which was higher in control samples (Table 1). In contrast, adhesiveness, chewiness and springiness were not affected by freezing. Products obtained from unfrozen beef were scored higher in sensory evaluation in terms of juiciness and tenderness (Table 1), whereas there were no differences between treatments in intensity of meaty aroma and taste. Results obtained highlight the impact of freezing on the quality of meat products, especially on the textural properties and sensory quality. Increased hardness and decreased juiciness were the result of changes in muscle structure. During the freezing of beef ice crystals are created and proteins undergo denaturation, which changes the muscle fibers structure [1,7]. This affects water-holding capacity, decreases moisture in raw muscles and affects the quality of sous-vide cooked meat.

Table 1 – Quality attributes of beef sous-vide products obtained from control (unfrozen) and frozen-thawed *longissimus lumborum* muscle (mean values ± SEM)

Attribute	Control (unfrozen)	Frozen-thawed	P-value
Hardness 1, N	21.1 ± 1.4	32.8 ± 2.2	*
Hardness 2, N	24.4 ± 1.6	38.2 ± 2.6	*
Cohesiveness, -	0.60 ± 0.01	0.54 ± 0.01	**
Juiciness, points	7.02 ± 0.11	5.08 ± 0.15	**
Tenderness, points	7.17 ± 0.16	5.71 ± 0.18	*

* a difference significant at $P < 0.05$; ** a difference significant at $P < 0.01$

IV. CONCLUSION

The freeze-thaw cycle affects the quality of sous-vide cooked beef by changing the color, texture and eating quality of the products. Although, the color changes might be limited by serving products with sauce or after additional thermal treatment, decreased juiciness and increased hardness will reduce consumers' acceptance of the products. Therefore, to obtain good quality sous-vide products it is recommended to use unfrozen beef.

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