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SOUS-VIDE BEEF WITH VINEGAR, BUTTERMILK OR BEER

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I. INTRODUCTION

Marinating is a traditional and widely used technique in both gastronomy and the meat industry. It aims to improve the sensory quality of meat, its technological properties (e.g., cooking yield), and inhibit microbial growth [1]. A variety of ingredients are used, including spices, herbs, and a liquid base such as oil, fruit juices, vinegar, wine, beer, or fermented dairy products [1,2]. Acidic marinades are particularly recommended, as they lower the pH and enhance meat tenderness [2]. This study investigates the effects of marinating beef in apple cider vinegar, buttermilk, and beer, combined with low-temperature processing under vacuum conditions (sous-vide).

II. MATERIALS AND METHODS

In the study 27 *longissimus lumborum* muscles from young (approximately 20 months old) Polish Holstein-Friesian bulls, after 14-day wet aging, were used. The muscles were divided into steaks, which were allocated to 4 groups – control (C) and marinated. Three marinades were prepared. The base consisted of: salt, bay leaf, cloves, allspice, marjoram, sugar, and pepper. To the spice mixture prepared in this way, the following were added per 1 kg of meat: 250 ml of apple vinegar and 250 ml of water (V); 500 ml of buttermilk (BT) and 500 ml of light beer (BE). After 24 hours of marinating under refrigerated conditions (4°C), the samples were processed in the sous-vide device at 60°C for 4 h. Warner-Bratzler Shear Force (WBSF) was determined using Instron 5942 (Instron, Norwood, USA), cross-section color using CR-400 Konica Minolta Chromameter, whereas tenderness, juiciness and cross-section color acceptability were assessed by panellists on a 10-point scale [3]. Statistica 13.3 was used for the data analysis. The data were subjected to analysis of variance using ANOVA, by considering a level of significance $p < 0.05$. To compare sensory analysis results, a non-parametric Mann-Whitney U test was applied.

III. RESULTS AND DISCUSSION

The results are presented in Table 1. The marinades used in the experiment had a significant effect ($p < 0.001$) on all the examined parameters except for juiciness. Both buttermilk and beer marinades significantly reduced cooking loss in contrast to vinegar marinade, which had the same cooking loss as control samples. WBSF values decreased by 41% (BT), 46% (BE), and 50% (V), which was consistent with higher tenderness scores in sensory evaluations. Samples marinated and sous-vide processed obtained significantly higher tenderness scores than control samples. However, vinegar and beer marinades resulted in less desirable cross-sectional color (5.7 points), while buttermilk-marinated and control samples were scored significantly higher (7.3 points). The instrumental color evaluation showed that the BM marinated samples had the most similar parameters a* and b* (which are chromatic color components) to the C sample parameters - the color of these two samples was rated the highest by the panelists. The results obtained in the experiment are consistent with the literature [1,3]. Many authors confirmed the beneficial effect of acidic marinades on tenderness, as reduced pH can lead to a weakening of the muscle structure, increased proteolysis by cathepsins and increased conversion of collagen into gelatin - which results in increased tenderness of the finished products [2,4].

Table 1 – The influence of marinating and marinade type on the quality of sous-vide beef steaks (mean values and standard error of mean, SEM)

Attribute	C	V	BT	BE	p-value
Cooking loss [%]	$28.6^{a} \pm 0.27$	$28.21^{a} \pm 0.28$	$22.1^{b} \pm 0.4$	$21.9^{b} \pm 0.9$	***
WBSF [N]	$30.2^{a} \pm 1.2$	$15.4^{c} \pm 0.4$	$17.93^{b} \pm 0.4$	$16.3^{bc} \pm 0.8$	***
L*	$47.9^{a} \pm 0.9$	$47.1^{a} \pm 0.8$	$42.8^{b} \pm 0.4$	$41.3^{b} \pm 0.5$	***
a*	$15.9^{a} \pm 0.4$	$10.96^{c} \pm 0.16$	$13.9^{b} \pm 0.5$	$3.6^{d} \pm 0.4$	***
b*	$9.37^{a} \pm 0.27$	$7.13^{b} \pm 0.28$	$9.01^{a} \pm 0.19$	$6.90^{b} \pm 0.24$	***
Sensory quality [points]					
Tenderness	$7.07^{b} \pm 0.14$	$7.81^{a} \pm 0.12$	$8.22^{a} \pm 0.15$	$7.88^{a} \pm 0.14$	***
Juiciness	7.21 ± 0.21	7.20 ± 0.21	7.26 ± 0.22	7.33 ± 0.22	NS
Color (cross-section)	$7.33^{a} \pm 0.29$	$5.72^{b} \pm 0.17$	$7.35^{a} \pm 0.21$	$5.71^{b} \pm 0.16$	***

$^{a-c}$ – mean values in rows with different superscripts differ significantly at $p < 0.05$; *** $p < 0.001$, NS - none significant differences ($p > 0.05$); Sensory assessment on 1–10 scale, tenderness (1, extremely tough; 10, extremely tender), juiciness (1, extremely dry; 10, extremely juicy), color acceptability (1, not acceptable; 10, very desirable); C-control, V-vinegar, BT-buttermilk, BE-beer

IV. CONCLUSION

The use of acidic marinades - apple cider vinegar, buttermilk, and beer - improved the tenderness of sous-vide beef. Among them, the buttermilk marinade emerged as the most promising, offering both technological and sensory benefits. These findings demonstrate the potential of incorporating fermented dairy products and traditional liquids into modern, low-temperature meat processing. Such strategies contribute to the development of tender, flavorful, and health-supporting meat products, including those suitable for older consumers with chewing difficulties. Moreover, the approach supports the goals of sustainable meat production, enabling the utilization of by-products (like buttermilk) and meeting the rising demand for minimally processed, functional foods.

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