EFFECTS OF TEMPERATURE AND TIME ON INDIGENOUS BACTERIA OF DRY-AGED BEEF

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I. INTRODUCTION

The dry aging process of beef exposes unpackaged meat to cold, facilitating surface drying while controlling temperature, relative humidity, and airflow [1]. It is a traditional method that not only influences its sensory characteristics but also the microbiological safety of the product. In this context, understanding the behavior of microorganisms such as *Escherichia coli* (*E. coli*), *Listeria sp*., and psychrotrophic bacteria (PCA), which could be part of the native microbiota of meat, plays a crucial role as indicators of food quality and safety. The presence of these microorganisms can indicate contamination and deterioration of the meat, impacting its safety and quality. Therefore, this study aims to evaluate the effect of different temperatures and periods of dry aging of beef on the growth of *Escherichia coli*, *Listeria sp.* and psychrotrophic bacteria.

II. MATERIALS AND METHODS

Six striploins (*Longissimus thoracis and lumborum*) weighing an average of 2.2 kg each, from Nelore bulls, were used in this study. The samples were taken from both the right and left sides of the carcasses. The samples were randomly distributed among three maturation chambers set at different temperatures: 0 °C, 3 °C, and 7 °C. The air velocity was 2.5 m/s, with a relative humidity of 75%. The samples were aged for 40 days, with evaluations conducted at 0, 10, 20, and 30-day intervals. To obtain representative samples from the internal portion of the cut, aseptic collection from five different points was performed. The enumeration of *Escherichia coli* was conducted on McConkey agar, with incubation at 37 °C for 24 hours. Enumeration of *Listeria sp.* was carried out on PALCAM agar, supplemented with selective antibiotic for *Listeria sp.*, and incubated at 37 °C for 48 hours. Enumeration of psychrotrophic bacteria was conducted on Plate Count Agar, incubated at 7 °C for 10 days. The results were expressed as log CFU/g. The data were analyzed using a mixed linear model including temperature and storage time as fixed effects, and replication as a random effect ($P < 0.05$), using Statgraphics® Centurion XVI version 16.1.11.

III. RESULTS AND DISCUSSION

The results of the bacterial counts are presented in Table 1. There was no interaction between storage time and temperature for the growth of *E. coli* in the internal portion of the meat ($P = 0.06$). However, significant differences were observed between storage days ($P < 0.001$), indicating a reduction in bacterial counts over time. Lower temperatures (0 °C and 3 °C) showed a trend toward lower bacterial counts, although this difference did not reach statistical significance.

Table 1. Microbiological counts in dry-aged beef under different temperature and time conditions.

Bacteria group	Temperature					
	Day	0 °C	3 °C	7 °C	mean	*P value*

E. coli	0	5.72±0.34^{aA}	5.78±0.42^{aA}	5.68±0.43^{aA}	5.72±0.22^{a}	0.373
	10	1.80±0.11^{bA}	<1.69±0.00^{bA}	1.72±0.04^{bA}	1.74±0.04^{c}	0.500
	20	1.73±0.04^{bA}	<1.69±0.00^{bA}	2.12±0.28^{bA}	1.84±0.10^{c}	0.127
	30	<1.69±0.00^{bA}	1.80±0.08^{bA}	2.16±0.30^{bA}	1.88±0.11^{bc}	0.192
	40	1.94±0.09^{bB}	2.38±0.23^{bAB}	2.85±0.29^{bA}	2.39±0.15^{b}	0.030
	mean	2.58±0.26 ^{A}	2.68±0.27^{A}	2.91±0.26^{A}		
	P value	< 0.001	< 0.001	< 0.001		
Listeria sp.	0	5.05±0.22^{aA}	4.61±0.25^{aB}	4.81±0.22^{aAB}	4.83±0.13^{a}	0.001
	10	2.37±0.30^{bcA}	1.76±0.08^{cA}	2.33±0.36^{bA}	2.16±0.16^{c}	0.092
	20	1.88±0.11^{cB}	2.45±.34^{bcAB}	2.64±0.38^{bA}	2.32±0.18^{bc}	0.025
	30	<1.69±0.00^{cB}	1.79±0.10^{cB}	2.92±0.47^{bA}	2.13±0.19^{c}	0.001
	40	3.09±0.29^{bA}	2.99±0.31^{bA}	2.43±0.30^{bA}	2.84±0.18^{b}	0.157
	mean	2.82±0.21^{A}	2.72±0.20^{A}	3.03±0.21^{A}		
	P value	< 0.001	< 0.001	< 0.001		
Psychrotrophic bacteria	0	4.82±0.18^{abB}	5.82±0.22^{aA}	5.35±0.14^{bAB}	5.33±0.13^{a}	0.003
	10	5.69±0.38^{aA}	4.31±0.18^{bB}	4.07±0.11^{bcB}	4.64±0.21^{ab}	< 0.001
	20	4.23±0.14^{bB}	6.08±0.26^{aA}	3.58±0.30^{cB}	4.63±0.26^{b}	<0.0001
	30	5.39±0.11^{bB}	5.04±0.18^{bB}	6.84±0.20^{aA}	5.83±0.30^{a}	<0.0001
	40	3.18±0.10^{cB}	3.11±0.16^{cB}	5.54±0.69^{bA}	4.01±0.35^{c}	< 0.001
	mean	4.46±0.17^{B}	4.87±0.21^{AB}	5.00±0.24^{A}		
	P value	< 0.001	< 0.001	< 0.001		

Different uppercase letters in the same row indicate differences between temperatures ($P < 0.05$). Different lowercase letters in the column indicate differences between times ($P < 0.05$). Detection limit: 1.69 log CFU/g.

There was interaction between storage time and temperature for the growth of *Listeria sp.* ($P<0.05$). The count of *Listeria* sp. decreased over the storage time, regardless of temperature. Initially, the count varied from 4.61 to 5.05 log CFU/g and progressively decreased in all treatments. Over time, counts at 3 °C were lower than at 7 °C, with intermediate values at 0 °C. Van Damme et al. (2022) also found a stronger inhibitory effect on *L. monocytogenes* growth in beef aged for 42 days at 2 °C compared to 6 °C. The results for the count of psychrotrophs indicated a significant interaction ($P < 0.001$) between temperature and time. The psychrotrophic count exhibited lower levels at both 0 °C and 3 °C compared to 7 °C ($P<0.05$) throughout time. Interestingly, no significant difference in psychrotroph count was observed between the two lower temperatures (0 and 3 °C).

IV. CONCLUSION

Temperature and aging time influenced the microorganism count. The count of *E. coli* and *Listeria* showed a reduction over time in all treatments. Also, lower temperatures (0 and 3 °C) showed a trend for lower bacteria counts. As for psychrotrophic bacteria, 0 °C and 3 °C significantly inhibited the bacterial growth compared to 7 °C, highlighting a reduction in counts at temperatures ≤ 3 °C. These findings underscore the importance of lower temperatures and aging time to control the growth of the indigenous bacteria of beef during the dry aging process.

REFERENCES

1. Kim, H. C., Ko, Y. J., Kim, M., Choe, J., Yong, H. I. & Jo, C. (2019). Optimization of 1D 1H quantitative NMR (nuclear magnetic resonance) conditions for polar metabolites in meat. Food science of animal resources. 39(1):1-12.
2. Van Damme, I., Varalakshmi, S., De Zutter, L., Vossen, E. & De Smet, S. (2022). Decrease of *Salmonella* and *Escherichia coli* O157:H7 counts during dry-aging of beef but potential growth of *Listeria monocytogenes* under certain dry-aging conditions, Food Microbiology. 104:10400.