THE IMPACT OF AGING PARAMETERS ON DRY-AGED BEEF FLAVOR

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I. INTRODUCTION

Over the past two decades, dry-aged beef has garnered interest from consumers and restaurants for its unique flavor, creating a premium for dry-aging [1]. To ensure quality, scientists researched dry-aged beef flavor development. However, the literature reports a variety of dry-aging conditions, making is a challenge to connect dry aging parameters to specific flavor attributes [2]. Therefore, it is valuable to examine dry-aging parameters and their impact on flavor development. Dry-aged flavor generation stems from aging (creation effects) and the degree of moisture loss (concentration effects) [5]. Conditions that create similar levels of either percentage moisture loss or aging time could improve understanding of the relationship between creation and concentration effects on dry-aged flavor. The Agenator system [3] offers the opportunity to evaluate flavor creation and concentration. Increase understanding could help develop an excellent eating experience and optimize dry-aging strategies for beef. Therefore, our objectives were to identify the individual and combined impact of creation and concentration on dry-aged beef yield, composition, and flavor development.

II. MATERIALS AND METHODS

Eleven pairs of upper 2/3 USDA Choice bone-in strip loins were collected 48 hours post-mortem and split in half, totalling 4 halved portions per animal (n=44). Halves were randomly assigned to one of four treatments: Two day wet-aged (Control), seven day boneless dry-aged (Bnls-7), twenty-eight day boneless dry-aged (Bnls-28), and twenty-eight day bone-in dry-aged (Bone-28). Loin halves were weighed and individually dry-aged in the Agenator system, a precisely controlled dry-age system, set at 70% relative humidity (± 0.1%), 0.8 m^3/min air flow (± 0.015m^3/min), 2°C temperature (± 0.5°C), and mass (± 5g) and recording every 10 minutes throughout aging. After aging, loins were weighed and fabricated for percentage total moisture, trim, and yield loss. Samples were evaluated for composition, water activity (a_w), pH, lipid oxidation, fatty acid composition, free amino acids (FAA), and sensory evaluation (trained and consumer panels, volatile composition, and Principal Component Analysis [PCA]). significance set at $P < 0.05$. Data were analysed as a completely randomized block design, with animal set as the block and significance set at $P < 0.05$.

III. RESULTS AND DISCUSSION

Among dry-aging treatments, Bnls-28 had greater moisture (19.5%) and trim loss (26.4%) compared to Bone-28 (12.5, 17.3%) and Bnls-7 (10.8, 22.3%), respectively. Bone-28 had greater moisture loss compared to Bnls-7. Bnls-7 had a greater percent yield compared to Bone-28 and Bnls-28. Loss was predicated on length of aging and moisture diffusion out from meat. Days of aging impacted saleable yield, though bone did improve yield under similar aging times. Bnls-28 had greater polyunsaturated fatty acid content compared to all treatments. Lipid oxidation and pH were greater in dry-age treatments, due to increased aging and time exposed to aerobic conditions. Results show creation effects, (Bnls-7 versus Bone-28), elicited dry-age flavor precursors. Added aging time (Bnls-28, Bone-28) increased FAA content in twenty-one amino acids compared to Bnls-7. This was expected, as enzymatic aging increases degradation of proteins into peptides and amino acids. Creation effects also increased volatile formation. Bone-28 had greater 1-Octen-3-ol (mushroom) content, and tended to have greater 2-methyl-butanal (chocolate), hexanoic acid (ether), and nonanal (green) compared to Bnls-7. Interestingly, Bnls-7 had greater 2,3-butanedione (buttery odor) and 4-methyl-undecane compared to Bone-28, though 4-methyl-undecane fell below the odor threshold for human detection [4]. Increased aging changed volatile composition complexity, which could contribute to flavor formation. Trained panel data showed Bone-28 favored fundamental palatability traits (juiciness, muscle fiber tenderness, connective tissue) with more fat-like and buttery flavor. Hedonic testing showed consumers found increased tenderness in Bone-28 samples. The concentration effect, (Bone-28 versus Bnls-28), showed subtle differences. Bnls-28 was greater in fourteen amino acids compared to Bone-28, when Bone-28 was greater in only one. Bnls-28 had greater 3-ethyl-2,5-dimethyl-pyrazine (nutty, roasted) content compared to Bone-28, suggesting moisture loss increased flavor intensity from precursors in raw (FAA) and cooked (volatiles). Bnls-28 was greater in salty intensity compared to Bone-28. Using PCA (Fig. 1), Bnls-28 flavor is strongly tied to basic beef taste attributes (salty, sweet, umami, beef ID, brown roasted) and oxidation (burnt, metallic, fishy, bitter, cardboardy). In contrast, Bone-28 flavor was strongly linked to fundamental meat palatability traits (juiciness, tenderness, and connective tissue) with more buttery and fat-like flavor and more pungent aromas (barnyard, animal hair, heated oil).

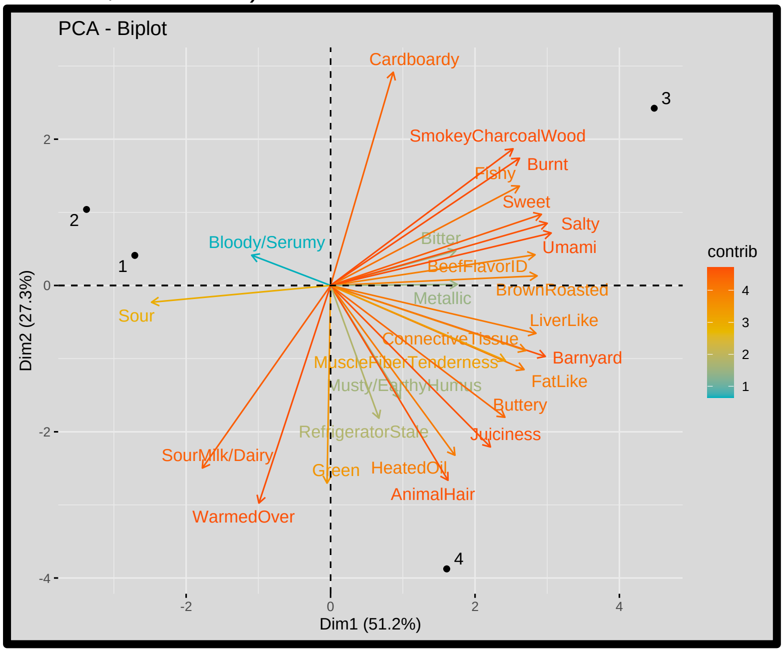

Figure 1. Principal Component Analysis (PCA) of trained sensory data: 1-Control, 2-Bnls-7, 3-Bnls-28, 4-Bone-28.

IV. CONCLUSION

Among dry-aging treatments, bone improved product yield and moisture. This alters both the final product's composition (pH, a_w, moisture, protein, fatty acids), and flavor precursors (free amino acids, volatiles). Comparing dry-aging creation effects (Bnls-7 vs Bone-28), added aging facilitated the generation of flavor and flavor precursors (volatiles and amino acids). By comparison, concentration effect (Bnls-28 vs Bone-28) exhibited greater attributes related to flavor intensity (volatiles, trained panel data).

REFERENCES

1. Dashdorj, D., Tripathi, V. K., Cho, S., Kim, Y., Hwang, I. (2016). Dry aging of beef: review. Journal of Animal Science and Technology 58: 1-11.
2. Terjung, N., Witte, F., Heinz, V. (2021). The dry aged beef paradox: why dry aging is sometime not better than wet aging. Meat Science 172: 1-12.
3. Lau, S. K., Ribeiro, F. A., Subbiah, J., Calkins, C. R. (2019). Agenator: an open source computer-controlled dry aging system for beef. HardwareX 6: 1-27.
4. Burdock, G. A. (2010). Fenaroli's Handbook of Flavour Ingredients. Boca Raton: CRC Press.
5. Savell, J. W., Gehring, K. (2018). Dry-aged beef revival: new thoughts on an old process. https://www.meatpoultry.com/articles/19412-dry-aged-beef-revival