EXPLORING THE BIOCHEMICAL BASIS FOR DARK BEEF DEVELOPMENT

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I. INTRODUCTION

The fresh meat quality attribute that consumers associate with the level of freshness and wholesomeness of beef is color. Products that do not meet the consumer's expectations for color cost the industry $3.73 billion annually, corresponding to 429.2 million pounds of beef discarded due to discoloration [1]. While extensive research has focused on beef color development in the past, the variability in beef color continues to plague the beef industry as 15% of retail beef does not meet the bright cherry-red color desired by consumers [2]. Beef color is influenced by myoglobin content, animal age, and the ultimate pH, which ranges from 5.5 to 5.8. Any deviations in ultimate pH are due mostly to pre-slaughter stress events that result in a condition known as dark-cutting beef. Yet, not all dark beef fits classical definitions of dark-cutting, this beef is known as atypically dark beef. Due to the vast differences in the mechanisms generating atypically and dark-cutting beef, there is a critical need to explore the biochemical basis for dark beef development and determine whether post-harvest processing strategies could reduce the incidence of dark beef in the marketplace.

II. MATERIALS AND METHODS

All procedures used were approved by the Virginia Tech Institutional Animal Care and Use Committee (#23-244). Twenty steers were randomly assigned into four treatments. Control (CON) cattle received saline injections 24 and 48 hours prior to harvest. In contrast, another group of cattle received two doses of 0.06 mg/kg of epinephrine at these same time points (T-2D). The remaining steers were assigned equally to either a single dose of epinephrine at 24 hours (T-24) or 48 hours (T-48) prior to harvest. At 1-hour post-harvest, carcasses were split and one side was subjected to electrical stimulation (ES, 300V, 15 Hz), while the other side served as a control. Samples from the liver and *Longissimus* muscle were collected pre-, post-, and 24 hours post-ES for metabolite and pH analyses. After 24 hours of chilling, color analyses were performed on 2.54 cm steaks collected from each side and aged for either 1, 7, or 14d. Data were analyzed as a completely randomized design in a 4 (epinephrine injections) x 2 (ES) factorial arrangement. The aged steak color was analyzed as repeated measurements. Differences were considered statistically significant when $P \leq 0.05$.

III. RESULTS AND DISCUSSION

All epinephrine treated animals had reduced initial glycogen concentrations (Table 1). Lactate, G6P, and glucose didn't differ across treatments at 1 hr postmortem. Muscle from CON, T-24, and T-48 animals had a decrease in pH after ES treatment, however, no post-ES pH decline was observed for T-2D (Figure 1). Ultimate pH was affected by epinephrine injections as muscle from T-2D cattle resulted in carcasses with higher ultimate pH values. As expected, meat color was altered by epinephrine injections (Figure 2). Highest lean L* and a* values were noted in carcasses of CON animals whereas T-2D had the lowest values. Animals treated with one dose of epinephrine at either 48h or 24h pre-harvest showed intermediate color values. ES improved beef color, even from stressed, dark carcasses.

Table 1 – Effect of epinephrine injections on *Longissimus lumborum* metabolite concentrations at 1 hour postmortem.

Traits	Treatments				Pr > F
	Control	T-48	T-24	T-2D	
Lactate, µmol/g	5.86	5.47	3.11	3.83	0.7056
Glycogen, µmol/g	58.91a	35.31b	39.84b	27.61c	0.0001
G6P, µmol/g	5.86	5.47	3.11	3.83	0.3251
Glucose, µmol/g	3.09	2.51	2.02	1.71	0.4282
Liver Glyc. Pot., µmol/g	338.86	378.73	461.17	430.80	0.0109

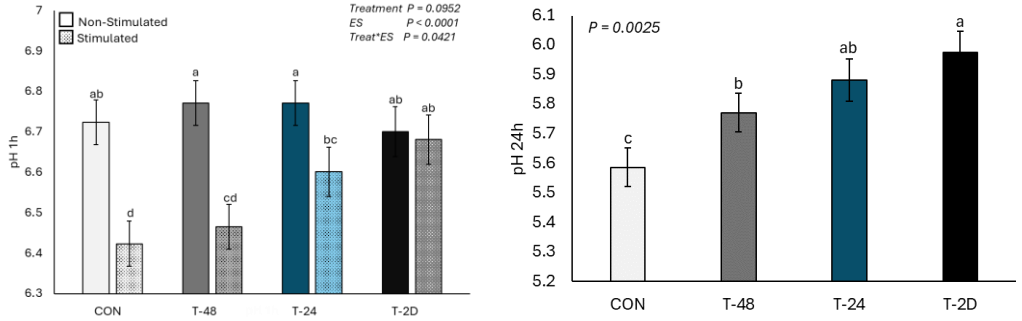

Figure 1. Effect of epinephrine injections and electrical stimulation on pH of *Longissimus thoracis*.

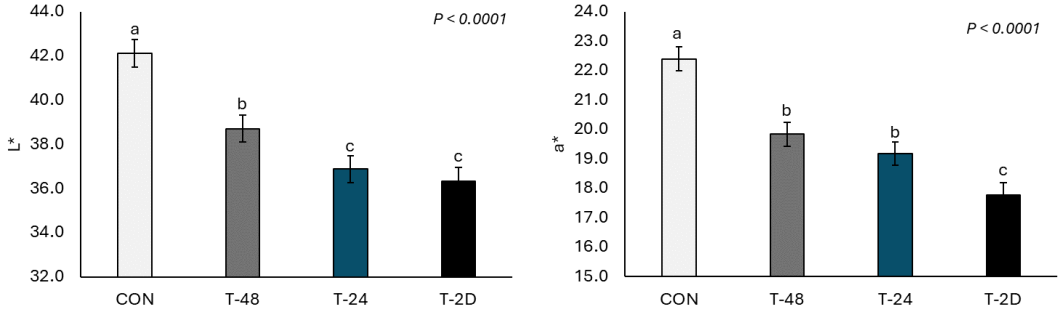

Figure 2. Effect of epinephrine injections and electrical stimulation on luminosity (L*, left) and redness (a*, right) of *Longissimus thoracis* over aging time.

IV. CONCLUSION

Two doses of epinephrine consistently lead to the production of dark-cutting beef. On the other hand, a single dose of epinephrine, regardless of the timing of the injection, produced the atypical dark beef phenotype. ES enhances the color of dark beef. Further research is underway to better understand the biochemical and physiological mechanisms driving the development of dark beef phenotypes.

REFERENCES

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