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Effects of Adding Egg Powder from Hens Immunized Against Phospholipase α2 on Ground Striploin Shelf Life

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Cover Page Footnote

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K-STATE Research and Extension

CATTLEMEN'S DAY 2023

KANSAS STATE UNIVERSITY CATTLEMEN'S DAY

Effects of Adding Egg Powder from Hens Immunized Against Phospholipase α2 on Ground Striploin Shelf Life

C. Velasco Ayala, L.A. Koulicoff, C.K. Chun, T.G. O'Quinn, E. Boyle, M. Richards,[1] C.K. Jones, and M.D. Chao

Abstract

The present study investigated the effect of incorporating three levels (0.4%, 0.8%, and 1.6%) of dried egg powder (EP) containing anti-phospholipase α2 (aPLA2) in ground striploin for its potential to extend ground striploin shelf life. Ten U.S. Department of Agriculture choice striploins were ground, formed into patties and overwrapped for retail display. Impacts on beef discoloration, L* (lightness), a* (redness), and b* (yellowness) parameters, and lipid oxidation over a 7-day retail display period were studied, and the fatty acid profile of the patties was examined. Throughout the 7 days of retail display, a* and b* values decreased ($P < 0.05$) and visual discoloration increased ($P < 0.05$) independently from egg powder inclusions. Lipid oxidation increased ($P < 0.05$) for all treatments throughout the 7-day display period, and beef patties containing 1.6% EP had higher ($P < 0.05$) lipid oxidation than the rest of the treatments. Furthermore, the addition of 1.6% EP to ground striploin increased the relative percentage of C11-18:1 trans, C18:2, C18:3, C20:1, and C22:6 fatty acids, but decreased the relative percentage of C17:0 and C17:1 when compared to other treatments ($P < 0.05$). There was also a decrease ($P < 0.05$) in the relative percentage of phosphatidylethanolamine and an increase ($P < 0.05$) in phosphatidylcholine with the 1.6% EP treatment when compared to the control. These results indicated that the inclusion of aPLA2 EP may be able to preserve phospholipid integrity in beef but was unsuccessful in inhibiting lipid oxidation.

Introduction

Beef is a nutritious food product with a relatively short shelf life because of its susceptibility to attack by free radicals resulting in lipid oxidation. Lipid oxidation in beef produces undesirable off-flavors, discoloration, and loss of nutrients. A previous study demonstrated that lipid oxidation is enhanced by the hydrolysis of phospholipids by phospholipase α2 (PLA2) in beef. Anti-phospholipase α2 (aPLA2) is an antibody that has been shown to inhibit PLA2 activity, and aPLA2 can be mass-produced in eggs from hens immunized against PLA2. The resulting eggs can be spray- or freeze-dried into egg powder (EP) to preserve the antibody activity. This study aimed to investigate the effect of incorporating three levels of aPLA2 egg powder on ground striploin shelf life.

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Experimental Procedures

Vacuum packaged U.S. Department of Agriculture (USDA) choice striploins from ten different beef carcasses were obtained from a USDA facility at 2 days postmortem. The next day, each loin was ground, divided into four equal batches, hand mixed with 0, 0.4, 0.8, or 1.6% of dried EP containing aPLA2 (w/w), vacuum packaged, and stored at 36°F for 14 days. After the storage period, each batch of ground striploin was formed into four 0.25-lb patties, overwrapped and randomly assigned to one of the three retail display periods (day 0, 4, and 7) at 35.6°F. Percent visual discoloration was determined using a trained panel (n = 7). Additionally, L*, a*, and b* were measured using a colorimeter each day of display on the day 7 patties. At the end of each sample's designated display period, patties were removed from the overwrapped packaging, repackaged in vacuum packaging, and stored at -112°F until analysis. Enzymatic activity of aPLA2 from EP was assessed using an enzyme-linked immunosorbent assay (ELISA). Lipid oxidation status was measured on samples from all three retail display periods. The fatty acid and phospholipid profiles were determined on the day 0 samples.

Results and Discussion

The aPLA2 activity was confirmed for the egg powder used on the patties. As expected, a* and b* values decreased ($P < 0.05$), and visual discoloration increased ($P < 0.05$) for all treatments throughout the 7 days of retail display (Figures 1, 2, and 3). However, the inclusion of EP had no effect on beef patty visual discoloration, a*, or b* ($P > 0.05$). The L* value was not altered ($P > 0.05$) due to EP concentration nor display day (Figure 4). Lipid oxidation increased ($P < 0.05$) for all treatments throughout the 7-day display period (Figure 5). Beef patties containing 1.6% EP had higher ($P < 0.05$) lipid oxidation than the rest of the treatments (Figure 6). The addition of 1.6% EP to ground striploin increased the relative percentage of C11-18:1 trans, C18:2, C18:3, C20:1, and C22:6 fatty acids, but decreased the relative percentage of C17:0, and C17:1 when compared to the other treatments ($P < 0.05$, Table 1). Adding more than 0.8% of EP containing aPLA2 in ground beef altered the fatty acid profile by increasing the content of some polyunsaturated fatty acids, particularly 18:2, which likely led to the enhanced lipid oxidation in ground striploin patties. The PC relative percentage was higher for the 1.6% EP treatment compared to the control, which is possibly due to the inhibition of PLA2 by aPLA2 in the EP ($P < 0.05$; Table 2).

Implications

Inclusion of EP containing active aPLA2 in beef patties did not demonstrate any direct effect in extending beef shelf life, possibly due to the alteration of fatty acid profile introduced by the egg powder.

Acknowledgments

The authors thank the Mark and Kim Young Undergraduate Research Fund for partial support of this research.

Table 1. Comparison of fatty acid profiles of beef patties with the addition of 0%, 0.4%, 0.8%, and 1.6% of egg powder containing antiphospholipase α2

	Treatment					
Fatty acid	**0%**	**0.40%**	**0.80%**	**1.60%**	**SEM[1]**	***P*-value**
14:0	2.60	2.38	2.31	2.36	0.15	0.12
14:1	0.62	0.55	0.54	0.54	0.05	0.14
16:0	29.24	29.12	29.26	29.20	0.39	0.94
16:1	3.44	3.37	3.07	3.04	0.22	0.24
17:0	1.01[a]	0.98[b]	0.96[bc]	0.94[c]	0.06	<0.01
17:1	0.77[a]	0.74[ab]	0.73[bc]	0.71[c]	0.05	<0.01
18:0	13.22	13.17	13.22	13.10	0.29	0.54
18:1	37.91	37.98	38.16	37.75	0.72	0.79
9-18:1 trans	1.89	1.83	1.78	1.77	0.13	0.11
11-18:1 trans	1.34[b]	1.37[ab]	1.39[a]	1.38[a]	0.03	0.03
18:2	4.93[b]	5.38[ab]	5.52[ab]	6.05[a]	0.45	0.02
18:3	0.20	0.20	0.21	0.21	0.01	0.18
20:1	0.15[b]	0.16[a]	0.16[a]	0.16[a]	0.01	0.03
20:3	0.43	0.43	0.41	0.40	0.05	0.72
20:4	1.53	1.59	1.56	1.62	0.20	0.93
20:5	0.11	0.11	0.11	0.11	0.02	0.93
22:4	0.24	0.25	0.24	0.23	0.03	0.92
22:5	0.33	0.32	0.30	0.30	0.04	0.60
22:6	0.03[d]	0.05[c]	0.08[b]	0.11[a]	0.01	<0.01
SFA[2]	46.07	45.65	45.75	45.61	0.53	0.52
MUFA[3]	46.12	46.00	45.82	45.36	0.77	0.43
PUFA[4]	7.81	8.35	8.43	9.03	0.77	0.23

[abcd] Values with different superscripts indicate a difference within each row.

[1]Standard error of the mean.

[2]Saturated fatty acids

[3]Monounsaturated fatty acids.

[4]Polyunsaturated fatty acids.

Table 2. Phospholipid profile of beef patties with the addition of 0%, 0.4%, 0.8%, and 1.6% of egg powder containing antiphospholipase α2

	Treatment					
Phospholipid (%)	0%	0.4%	0.8%	1.6%	SEM[1]	*P*-value
PE[2]	29.35[a]	30.16[a]	24.86[ab]	18.73[b]	2.83	<0.05
PC[3]	54.98[b]	58.35[b]	63.60[ab]	70.59[a]	2.62	<0.05
SM[4]	15.01	11.49	11.11	10.38	3.01	0.52

[ab]Values with different superscripts indicate a difference within each row.
[1]Standard error of the mean.
[2]Phosphatidylethanolamine.
[3]Phosphatidylcholine.
[4]Sphingomyelin.

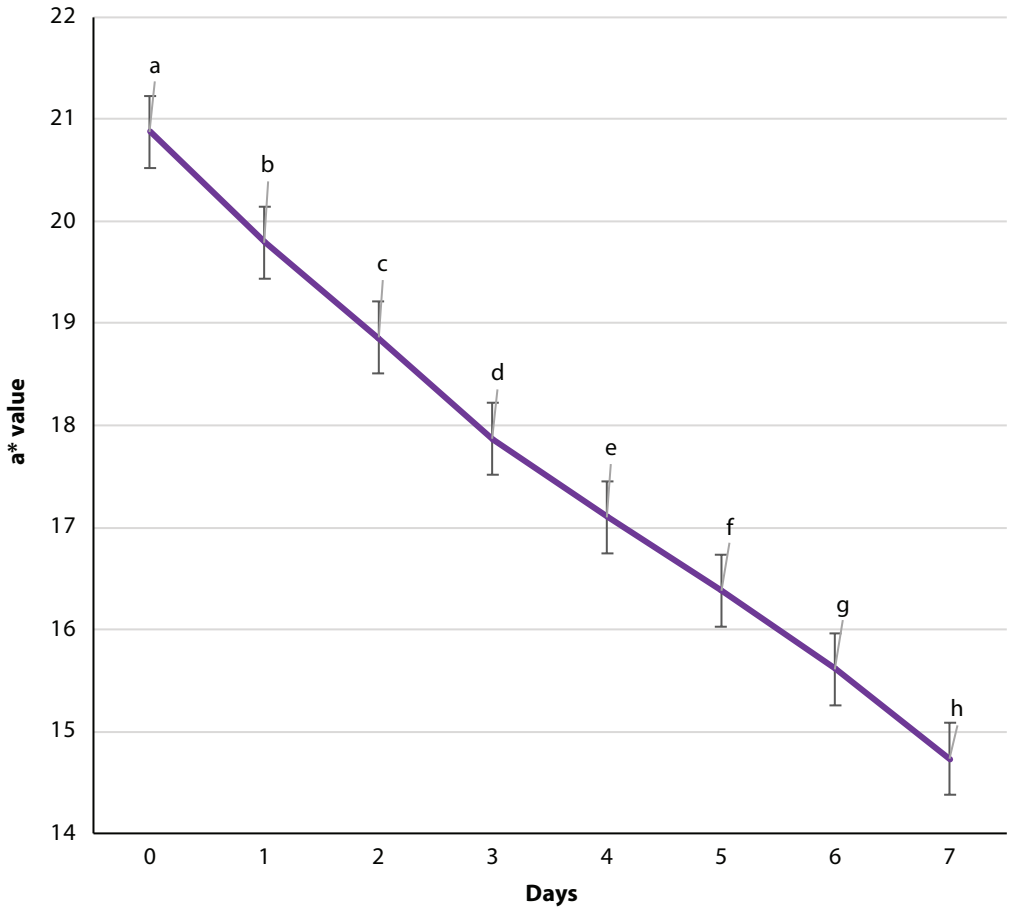

Figure 1. The a* values pooled across treatment for 7-day patties ($P < 0.05$).

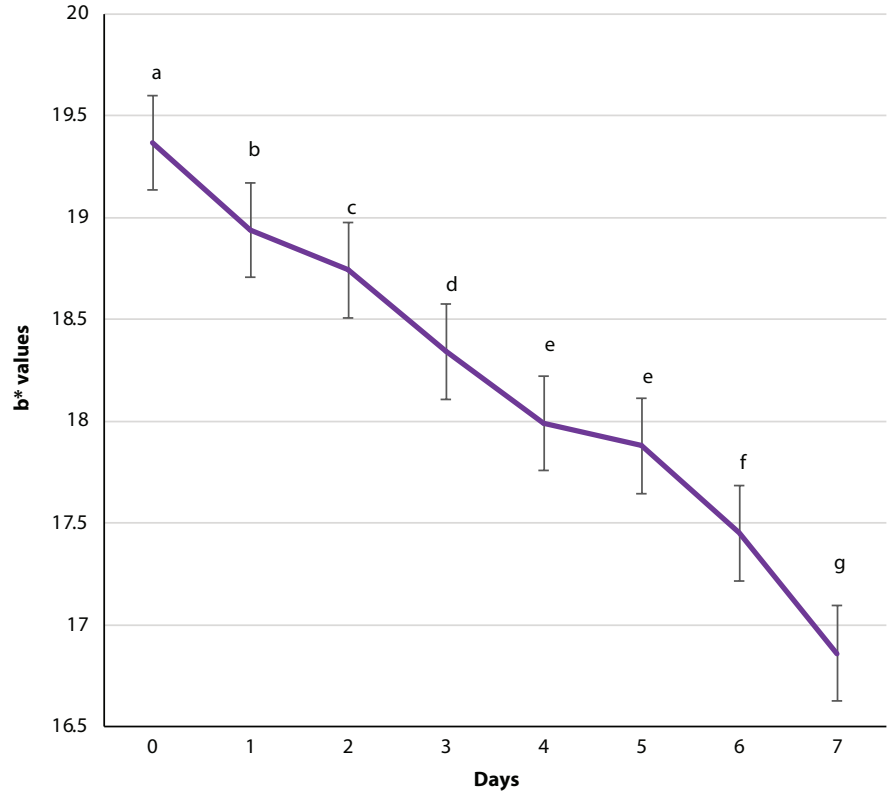

Figure 2. The b* values pooled across treatment for 7-day patties ($P < 0.05$).

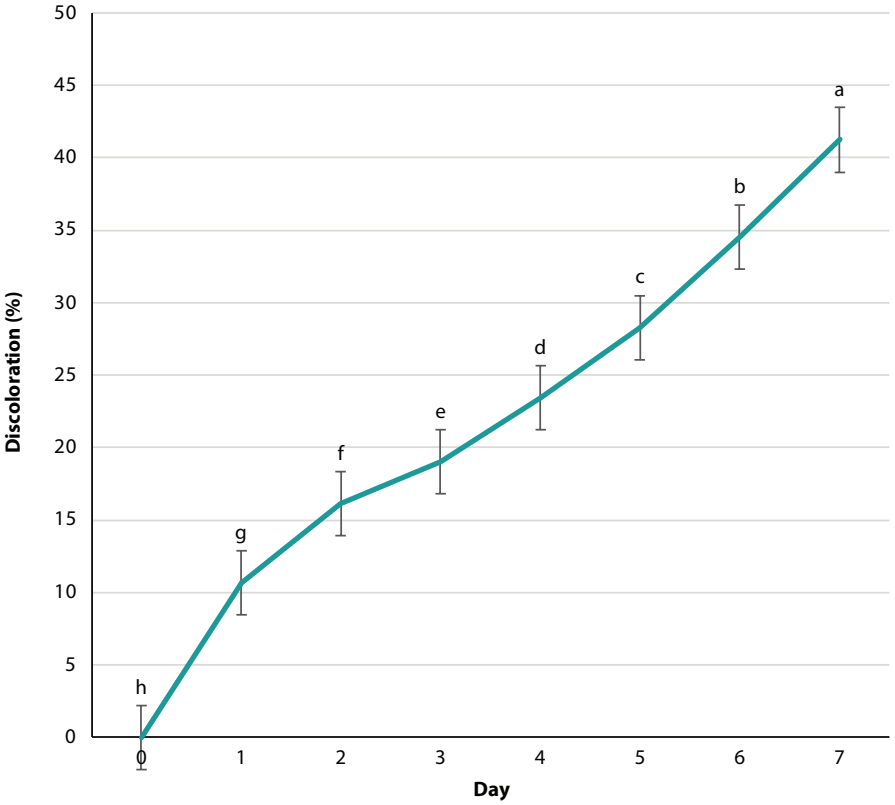

Figure 3. Visual discoloration pooled across treatments during 7 days of refrigerated display ($P < 0.05$).

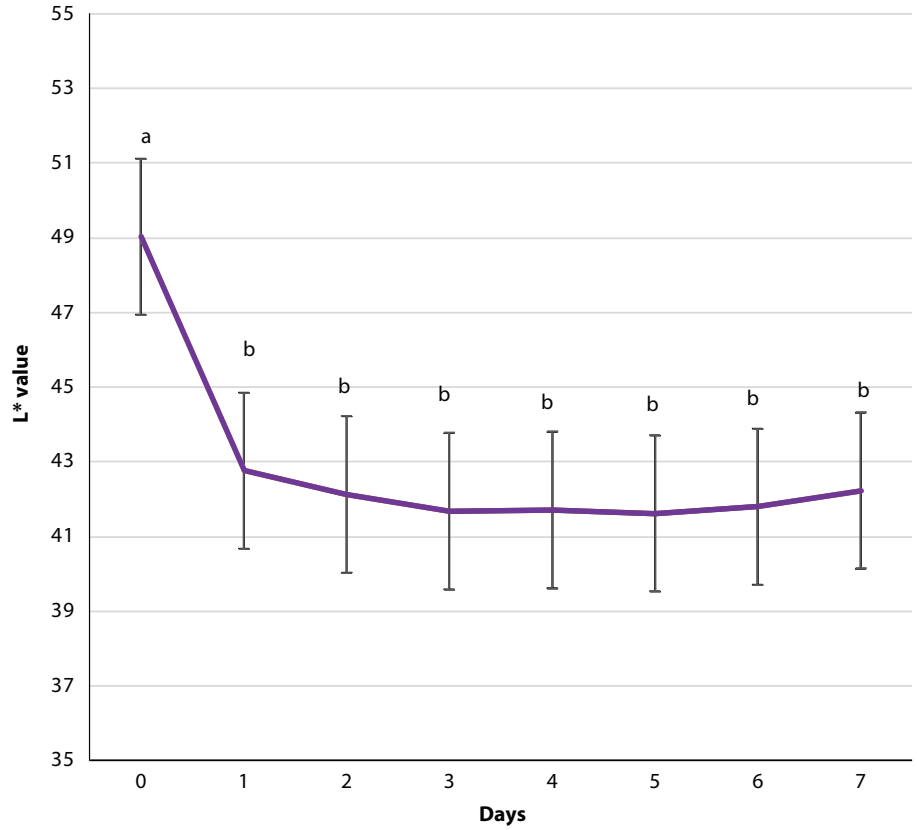

Figure 4. The L* values pooled across treatment for 7-day patties ($P < 0.05$).

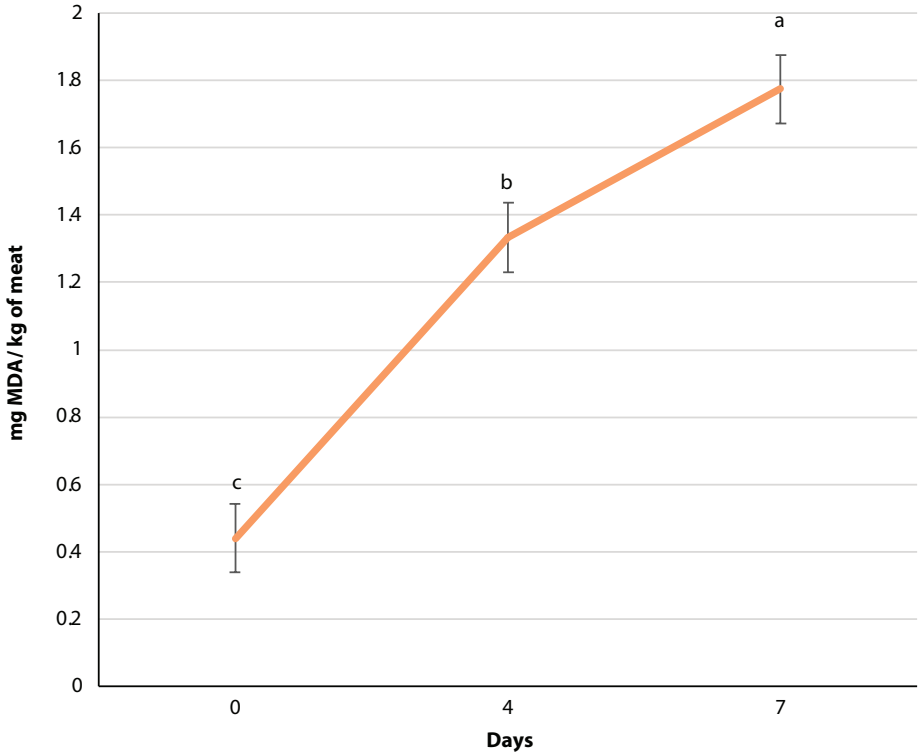

Figure 5. Pooled results across treatment for lipid oxidation for different display periods ($P < 0.05$).

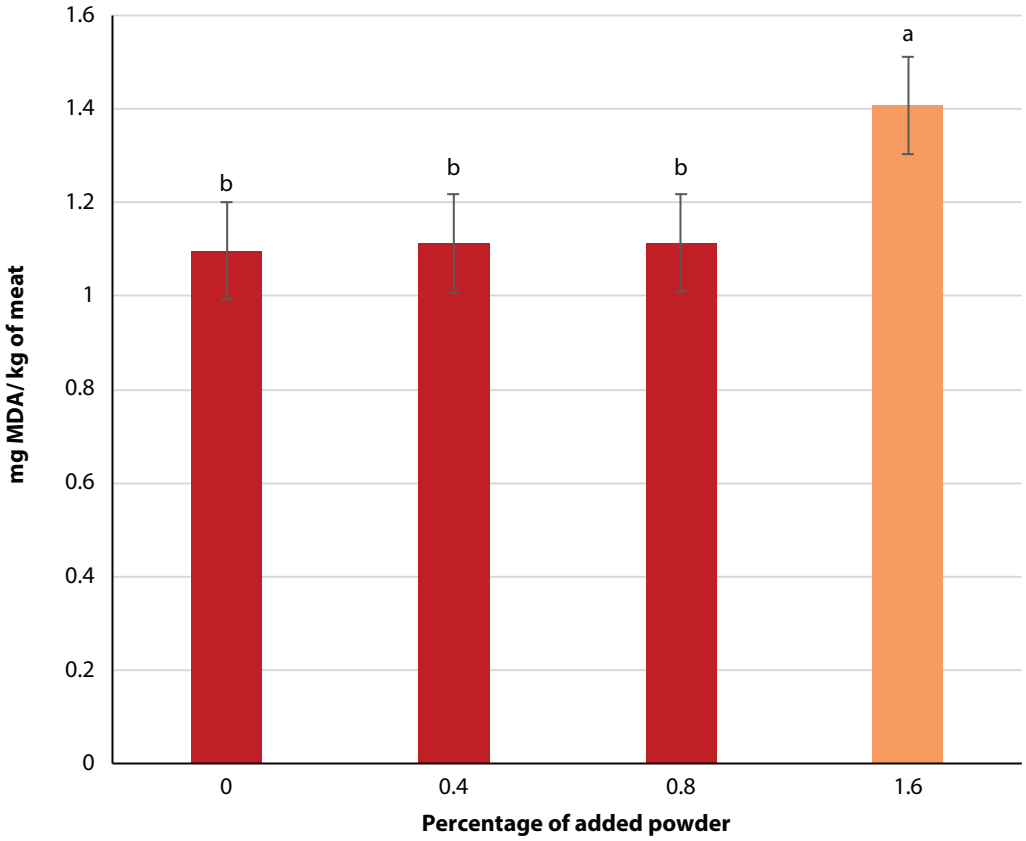

Figure 6. Pooled results across display days for lipid oxidation for different treatments ($P < 0.05$).