CONTROL OF LIPID OXIDATION WITH ANTIOXIDANTS DURING FROZEN PORK FAT TRIM SHELF LIFE

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I. INTRODUCTION

Frozen storage extends the shelf-life of pork due to reduced enzymatic and microbial activity; however, freezing pork also results in muscle and fat tissue damage and oxidative changes of aroma, flavor, and color. Although pork oxidation cannot be prevented, it can be delayed by improving pork quality, increasing freezing rates, optimizing storage temperatures, using oxygen-excluding packaging, and adding antioxidants prior to freezing. Benefits of an extended frozen pork trim shelf-life, including global supply chain and production schedule flexibility, are reasons to reduce oxidation rates. The objective of this research was to compare the effect of adding four antioxidants to ground pork fat trim and evaluating quality and oxidation rates during 12 m of storage at -17 C.

II. MATERIALS AND METHODS

Pork fat trim, targeted at 58% fat, was collected from hams within 24 h of slaughter and processed at a commercial facility. Trim was ground through a 12.7 mm plate and x-rayed. At fall, 45 350 kg batches of trim were collected. Nine 350 kg batches per treatment were blended for three min with one of the five following antioxidant blends: control with no functional ingredients added, 70 ppm sodium nitrite, rosemary extract at 0.3% of the total formula, rosemary green tea (RGT) at 0.28% of the total formula, and citric acid-based vinegar at 0.35% of the total formula. Treatments were packaged in plastic, heat-sealed bags that were cased in a corrugate box with a case weight of 22.68 kg. There were two bags per corrugate box resulting in 14 boxes per replicate and 126 boxes per treatment. Treatments, quick frozen at a wind chill of -42 C, reached -28 C within 26 h and were stored in a commercial freezer at -17 C for up to 12 m. One week prior to each evaluation date, a box from each replicate was thawed in a commercial cooler to approximately 4.5 C and one of the two bags was randomly sampled. On the evaluation day, a sample was taken from the middle of each bag from each of the nine boxes per treatment for all analyses. Proximate and fatty acid analysis was determined. The aerobic plate count (APC), pH, hexanal and thiobarbituric acid (TBA) content, instrumental color, and sensory analysis using a trained panel was evaluated monthly for 12 m. Data analyses were generated by SAS Studio 3.8 with SAS 9.4 software (SAS Institute Inc., Cary, NC) using the PROC GLIMMIX procedure. Treatments were analyzed using a split-plot design with the whole plot factor of treatment and the subplot factor of month. One-way ANOVA was used to compare the proximate analyses and fatty acid profiles by treatment ($P < 0.05$). The effects of treatment and time on objective and sensory tests were analyzed using SAS software's least squared mean procedure ($P < 0.05$).

III. RESULTS AND DISCUSSION

The control and vinegar treatments at 61.65 and 61.15% fat, respectively, had higher ($P < 0.01$) percent fat than the nitrite, RGT, and rosemary treatments at 59.65, 59.38, and 57.34%, respectively,

and were higher than the 58% target. This was attributed to a small sample size out of a larger batch that was evaluated in real time on the production line which indicated all treatments were 58 ± 2% fat. There were slight differences ($P < 0.05$) in fatty acid profiles and proximate analyses among the treatments potentially due to sample collection in a commercial pork processing facility where hogs were sourced from multiple production facilities. The APC ranged from 2.47 to 2.98 $\log_{10}$ CFU/g throughout 12 m storage and 2.69 to 2.80 $\log_{10}$ CFU/g among individual treatments. Pork trim pH varied from 5.79 to 6.23 during storage. The nitrite treatment had a higher ($P < 0.05$) pH than trim containing rosemary. The malonaldehyde (MDA) level of rosemary and RGT treatments remained below 0.2 mg MDA/kg during storage (Table 1). Hexanal was similar ($P < 0.05$) for the control, rosemary, and RGT treatments and stayed at or below 0.1 mg hexanal/kg throughout the 12 m of storage. None of the treatments exceeded 1.0 mg hexanal/kg or reached levels of hexanal that would impact consumer sensory perception of oxidation [1]. The trained sensory panel ranked rancid aroma, cardboard aroma, and rancid and cardboard flavor on a 100-point scale. All treatments for all four measurements were below 7 on this scale at each month through month 10. The largest sensory differences among treatments occurred at 12 m of storage where the rancid aroma of the control treatment reached a score of 11.0 and was higher ($P < 0.05$) than all other treatments. The rancid aroma of the rosemary and RGT treatments, at 2.8 and 2.3, respectively, were similar ($P > 0.05$) and were lower ($P < 0.05$) than the control at month 12. The reaction of nitrite with myoglobin resulted in a browner trim based on lower a* and b* values; however, this would be acceptable for trim used in a cured finished product. All panel color scores were less than 3 on a 6-point National Pork Board color scale [2], and most treatments were below two on this scale.

Table 1 Least squared means of malonaldehyde (mg/kg) for pork fat blended with antioxidants (n=9) during 12 m of storage at -17 C

	Treatment						
Month	Control	Buffered Vinegar	Nitrite	Rosemary	Rosemary Green Tea	SEM[1]	P-value
0	0.16^{b}	0.67^{a}	0.10^{b}	0.05^{b}	0.05^{b}	0.08	P < 0.05
1	0.19^{b}	0.43^{a}	0.11^{b}	0.06^{b}	0.06^{b}	0.08	P < 0.05
2	0.39^{a}	0.34^{ab}	0.18^{bc}	0.05^{c}	0.05^{c}	0.08	P < 0.05
3	0.23^{ab}	0.43^{a}	0.36^{a}	0.05^{b}	0.05^{b}	0.08	P < 0.05
4	0.48^{b}	0.82^{a}	0.89^{a}	0.08^{c}	0.11^{c}	0.08	P < 0.05
5	0.51^{a}	0.56^{a}	0.62^{a}	0.12^{b}	0.09^{b}	0.08	P < 0.05
6	0.39^{b}	0.73^{a}	0.39^{b}	0.35^{c}	0.06^{c}	0.08	P < 0.05
7	0.31^{a}	0.29^{a}	0.19^{a}	0.05^{ab}	0.10^{ab}	0.08	P < 0.05
8	0.51^{a}	0.57^{a}	0.53^{a}	0.09^{b}	0.09^{b}	0.08	P < 0.05
9	0.36^{b}	0.62^{a}	0.52^{ab}	0.13^{c}	0.10^{c}	0.08	P < 0.05
10	0.82^{a}	0.80^{a}	0.82^{a}	0.06^{b}	0.06^{b}	0.08	P < 0.05
11	0.50^{a}	0.44^{a}	0.56^{a}	0.17^{b}	0.06^{b}	0.08	P < 0.05
12	0.87^{ab}	1.03^{a}	0.78^{b}	0.06^{c}	0.08^{c}	0.08	P < 0.05

$^{a-c}$ Least squared means with different superscripts within rows are different ($P < 0.05$)

[1] Standard error of the mean

IV. CONCLUSION

Rosemary and RGT, at the levels used in this study, were effective antioxidants at slowing oxidation of frozen pork trim during 12 m of storage. The use of an antioxidant treated pork fat trim will allow flexibility in production scheduling and supply chains.

REFERENCES

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