SEX, SIRE AND AGING EFFECTS ON LIPIDS AND PROTEIN OXIDATIVE STABILITY IN COOKED LAMB DURING STORAGE

Renyu Zhang[1*], Prianshu Chawla[1,2], Chathurika Samarakoon[1,2], Mustafa M. Farouk[1]

[1] AgResearch Ltd, Palmerston North, New Zealand

[2] Waikato Institute of Technology, Hamilton, New Zealand

*Corresponding author email: renyu.zhang@agresearch.co.nz

I. INTRODUCTION

Dry-aging is a processing strategy to produce meat with high-quality and unique flavors. Dry-aging can be achieved by traditional methods without any packaging or in-bag dry-aging (BD). BD is a relatively new technique to produce dry-aged meat with more consistent quality and increased yields [1]. However, factors affecting the quality and stability of dry-aged meat are complex. The interplay of dehydration, oxidation, and microbial activity has been suggested to affect the development of characteristic dry-aged meat flavor [1], while other factors such as genetics, sire, and sex remain less explored. Certain sires were reported to produce lamb meat with more stable color during storage (color-stable) [2] and such advantages may further influence other quality traits and stability during processing and storage [3]. This study aimed to determine the impacts of sex, sire, and aging type on the oxidative stability of lipids and protein in raw and cooked lamb meat during chilled storage.

II. MATERIALS AND METHODS

Paired hindlegs (n=40) were collected from twenty lambs (~46 weeks) of different sexes (ram/ewe, n=10 each sex) and sire groups (color-stable and color-labile, n=10 each sire) as described by Zhang [3]. The paired legs were randomly assigned wet-aging at -1.5 °C and in-bag dry-aging in a dry-aging bag (Tublin®10) at 2 ± 0.5 °C, 0.5 $m.s^{-1}$ air velocity, and relative humidity of 75 ± 5% for 21 days, resulting 8 treatment combinations (n=5 each) including wet-aging (W) and BD of (1) & (2) male lambs from color-stable sire; (3) & (4) male lambs from color-labile sire; (5) & (6) female lambs from color-stable sire; (7) & (8) female from color-labile sire. Forty chops were produced from aged lamb and cooked *sous vide* at 72 °C for 1 h followed by cooling down in an ice slurry for 1 h. Cooked lamb chops were deboned and ground into mince using a food processor. Cooked mince was placed in a form tray and overwrapped with PVC film and stored in a chiller at 4 °C for up to 28 days. Sub-samples were taken during storage for 0, 7, 14, 21, and 28 days. Lipid and protein oxidation of raw (uncooked) and cooked lamb samples were performed following thiobarbituric acid reactive substances assay (TBARS) and 2,4-dinitrophenylhydrazine (DNPH) method, respectively, as described by Zhang [4]. Results were analyzed by analysis of variance in Genstat, specifying aging type, sire groups, sex, and their interactions as treatment effects with carcass IDs and the side within carcass as blocking factors.

III. RESULTS AND DISCUSSION

Low levels of lipid oxidation were found in raw samples regardless of aging type, sex, and sire group. Raw lamb from BD had higher TBARS than the meat from W ($P=0.058$, Table 1) due to the oxygen permeability of the dry-aging bag to allow for oxidative maturation and produce niche dry-aged meat flavor [1,4]. Cooking and chilled storage increased TBARS levels in all the lamb samples. Aging method was the primary factor driving the differences in TBARS content during the storage with higher levels observed in lamb meat from BD compared to W ($P<0.05$), suggesting the lipid is more susceptible to oxidation in cooked dry-aged lamb during chilled storage. Lamb meat from color-stable sire had lower TBARS values ($P=0.015$) than the labile sire after cooking, while such differences diminished during storage. Sex had no impact on the lipid oxidation in both raw and cooked lamb meat.

Table 1 Lipid and protein oxidation levels of raw and cooked lamb chops during storage for 28 days.

	In-bag dry-aging				Wet-aging				Pr > F		
	Male		Female		Male		Female		Sex	Sire	Aging
	Stable	Labile	Stable	Labile	Stable	Labile	Stable	Labile			
	Lipid oxidation (mg MDA/kg meat)										
Raw	0.42	0.29	0.36	0.40	0.34	0.24	0.28	0.27	0.931	0.331	0.058
Cooked and storage											
0 d	2.04	2.31	1.78	2.43	1.87	2.11	1.88	2.12	0.814	0.015	0.010
7 d	6.45	7.28	7.71	7.09	5.01	5.50	5.31	5.33	0.065	0.245	<.001
14 d	7.84	8.24	8.50	7.96	5.40	6.41	5.55	5.68	0.876	0.441	<.001
21 d	10.00	10.64	11.22	10.64	7.56	7.91	7.78	7.65	0.179	0.745	<.001
28 d	11.75	11.44	12.40	12.19	8.67	8.59	8.59	8.91	0.119	0.596	<.001
	Protein oxidation (nmol/mg protein)										
Raw	2.98	2.74	2.46	2.36	2.58	2.92	2.02	2.35	0.006	0.638	0.177
Cooked and storage											
0 d	2.68	2.43	2.27	2.53	2.58	2.62	2.42	2.55	0.318	0.729	0.420
7 d	3.28	3.32	2.89	2.54	3.39	3.21	2.48	2.77	0.005	0.792	0.702
14 d	2.99	2.88	2.63	2.79	3.37	3.14	2.62	2.83	0.080	0.969	0.065
21 d	3.99	3.43	3.20	3.39	3.96	3.91	3.28	3.03	0.047	0.695	0.265
28 d	4.31	3.02	2.83	3.33	3.56	3.02	2.97	2.77	0.095	0.262	0.373

MDA (mg malonaldehyde/Kg meat); protein carbonyl (nmol/mg protein).

Similar levels of protein carbonyl were observed in raw and cooked lamb meat regardless of sire groups and aging types. A sire group × aging type interaction was observed in raw lamb meat (P=0.046) with higher levels of carbonyls in dry-aged samples from color-stable sire compared to labile sire, while the opposite trend was observed in wet-aged lamb. Such findings suggested different oxidation pathways may be involved for lamb protein from two sire groups under different aging environments. On the other hand, sex was the main factor driving the changes in both raw and cooked lamb meat. Higher protein carbonyl contents were observed in aged samples from male lambs than the females before cooking (P=0.006) and following cooking and storage for 7 (P=0.005) and 21 days (P=0.047), suggesting more oxidatively stable meat may be produced from female lambs.

IV. CONCLUSION

BD enhanced TBARS levels in both raw and cooked lamb confirming the role of lipid oxidation in developing dry-aged meat flavor. Freshly cooked lamb meat from color-stable sire may have different eating qualities compared to labile sire due to the lower lipid oxidation levels. The superior stability of lamb meat from ewe may be beneficial for producing meat with more stable quality during storage.

ACKNOWLEDGEMENTS

This work was supported by the Ministry of Science and Innovation, New Zealand, and from the internal Strategic Science Investment Fund of AgResearch Limited (contract A19113).

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