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LIPID AND PROTEIN OXIDATION STATUS OF KOREAN NATIVE CHICKEN AND BROILER BREAST MEAT AFTER NINE MONTHS OF FROZEN STORAGE

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I. INTRODUCTION

As the global demand for premium chicken meat rises, consumers are prioritizing higher standards in their selection. In South Korea, Korean native chicken (KNC) has traditionally been consumed on special seasons as a premium meat due to its exceptional flavor and texture. In 2012, the South Korean government launched the “Golden Seed Project” to enhance KNC breeding. As a result of this project, a new KNC variety, Woorimatdag No. 1, was developed [1]. This breed was further improved into Woorimatdag No. 2 (WRMD2) to enhance growth performance compared to other KNC breeds. WRMD2 retains the unique organoleptic and nutritional characteristics of KNCs, making it highly suitable for native chicken meat production. To facilitate efficient distribution, KNC is commonly transported in a frozen state, as freezing effectively preserves the meat integrity by inhibiting microbial growth and slowing undesirable biochemical reactions, thus maintaining its quality during prolonged storage. [2]. However, despite its benefits, freezing inevitably leads to some quality deterioration compared to fresh meat. The formation and recrystallization of ice crystals during freezing and storage can degrade meat quality by disrupting cellular structures and breaking down muscle fibers, thereby increasing susceptibility to oxidation. Chicken meat contains high levels of pro-oxidative catalysts, such as myoglobin, iron, and unsaturated fatty acids, which promote lipid and protein oxidation even during frozen storage [2]. However, limited information is available on lipid and protein oxidation changes in WRMD2 during long-term frozen storage. Therefore, this study was conducted to evaluate the lipid and protein oxidation status of WRMD2 breast meat after nine months of frozen storage, using commercial broiler (CB) meat as a control.

II. MATERIALS AND METHODS

WRMD2 (n = 20, 1,550–1,650 g, 12 weeks old) and CB (n = 20, 1,150–1,250 g, 6 weeks old) were raised on an environmentally controlled farm and fed a commercial poultry diet. The birds were slaughtered using 65–80% CO_2 gas, and the carcasses were then transported to a laboratory. The breast meat (*pectoralis major*), skinless, was separated, vacuum-packaged using a PE/NY film (film thickness: 70 μm; maximum oxygen transmission rate: 30 $cm^3/m^2 \cdot$day at 20–25°C), and stored at −20°C for nine months. For the initial and final days of storage, ten samples were randomly selected, thawed at 4°C for 18 hours, pooled into five replicates by combining two breast specimens, and ground for analysis. Peroxide value (POV), carbonyl content, and sulfhydryl content were analyzed as previously described [2]. The content of 2-thiobarbituric acid reactive substances (TBARS) and volatile basic nitrogen (VBN) was determined as previously reported [1]. The p-anisidine value (pAV) was evaluated as previously described [3]. Data were expressed as mean values and standard deviations obtained from five replications. Statistical analysis was performed using SAS software (v.9.4) with one-way ANOVA and Duncan’s multiple range test.

III. RESULTS AND DISCUSSION

After nine months of frozen storage, the degree of lipid and protein oxidation generally increased in both CB and WRMD2 (Table 1). Initially, CB showed no significant changes in POV after frozen storage, whereas a significant increase in POV was observed in WRMD2. Both CB and WRMD2 exhibited significant increases in pAV and TBARS after frozen storage. The delayed increase in POV in CB may be due to the rapid breakdown of peroxides into secondary oxidation products during long-term frozen storage. This breakdown can possibly lead to an increase in pAV and TBARS, indicating ongoing oxidation [2]. At both the initial and final time points, WRMD2 exhibited significantly higher lipid oxidation values (POV, pAV, and TBARS) than CB, reflecting its higher susceptibility to lipid oxidation. This may be attributed to the high proportion of polyunsaturated fatty acids (PUFAs) in WRMD2. KNCs, including WRMD2, contain greater amounts of PUFAs, such as arachidonic acid and docosahexaenoic acid, compared to broilers [1]. Regarding protein oxidation, VBN increased significantly in both chicken groups after frozen storage. Similarly, a significant increase in carbonyl content was observed in both CB and WRMD2. However, only

CB exhibited a significant decrease in sulfhydryl content after frozen storage. The increase in protein carbonyl levels and a decrease in sulfhydryl content in chicken breast meat during frozen storage has also been reported previously [2]. The formation of protein carbonyls is accelerated by metal-catalyzed oxidation of myoglobin and lipids, whereas thiol groups in muscle fibers can be converted to sulfonic acid, which then crosslinks with disulfide bonds during storage [4]. Interestingly, WRMD2 showed less susceptibility to protein oxidation compared to CB, as evidenced by significantly lower values of VBN and sulfhydryl content than CB. This result may be due to differences in muscle fiber types and amino acid composition, which could potentially influence susceptibility to oxidation. Previous studies have reported that KNC contains both known and uncharacterized distinct proteins when compared to broilers [5].

Table 1 – Lipid and protein oxidation status of commercial broiler and Korean native chicken after 9-months of frozen storage

Traits	Treatment	Initial day	9-months	Pr > F*	Pr > F**	Pr > F***
Lipid oxidation						
POV (meq O_2/kg fat)	CB	2.04 ± 0.21^{B}	1.93 ± 0.35^{B}	0.5603	0.0266	0.0053
	WRMD2	2.34 ± 0.12^{Ab}	2.63 ± 0.22^{Aa}	0.0338		
pAV	CB	1.69 ± 0.30^{Bb}	9.14 ± 1.18^{Ba}	<0.0001	0.0075	0.0016
	WRMD2	3.42 ± 1.05^{Ab}	13.18 ± 1.54^{Aa}	<0.0001		
TBARS (mg malondialdehyde/kg)	CB	0.12 ± 0.02^{Bb}	0.16 ± 0.01^{Ba}	0.0011	0.0004	<0.0001
	WRMD2	0.16 ± 0.01^{Ab}	0.21 ± 0.01^{Aa}	<0.0001		
Protein oxidation						
VBN	CB	14.04 ± 0.53^{Ab}	16.09 ± 0.57^{Aa}	0.0004	<0.0001	<0.0001
	WRMD2	9.89 ± 0.46^{Bb}	11.15 ± 0.50^{Ba}	0.0032		
Carbonyl (nmol/mg protein)	CB	0.98 ± 0.07^{b}	1.26 ± 0.11^{a}	0.0016	0.0655	0.8453
	WRMD2	1.10 ± 0.10^{b}	1.25 ± 0.09^{a}	0.0349		
Sulfhydryl (nmol/mg protein)	CB	38.45 ± 1.87^{Aa}	35.50 ± 1.51^{Ab}	0.0253	0.0124	0.0203
	WRMD2	34.13 ± 2.35^{B}	31.30 ± 2.89^{B}	0.1273		

^{a,b} Means within same row with different superscript letters differ significantly ($P < 0.05$). ^{A,B} Means within same column with different superscript letters differ significantly ($P < 0.05$). POV, Peroxide value; pAV, p-Anisidine value; TBARS, 2-Thiobarbituric acid reactive substances; VBN, Volatile basic nitrogen. * indicates the *P*-value for the comparison between the initial and final time points within the same chicken breed. ** and *** indicate the *P*-values for the comparisons between CB and WRMD2 at the initial and final time points, respectively. CB, commercial broiler (control); WRMD2, Woorimatdag No. 2.

IV. CONCLUSION

This study demonstrated that long-term frozen storage significantly induced lipid and protein oxidation in both commercial and native chicken meat. Notably, WRMD2 showed a higher susceptibility to lipid oxidation, as evidenced by POV, pAV, and TBARS, while exhibiting less susceptibility to protein oxidation compared to CB, as indicated by VBN and sulfhydryl content. These findings provide preliminary insights into the chemical changes occurring during frozen storage, which could aid in regulating and optimizing the quality of native chicken meat products worldwide.

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