EFFECTS OF INDUCED-MOLTING ON PHYSICOCHEMICAL AND SENSORY PROPERTIES OF BREAST MEAT FROM SPENT LAYER

Ki Ho Baek[1*], Dicky Tri Utama[1], Seung Gyu Lee[1], Byoung Ki An[2] and Sung Ki Lee[1]

[1] Animal Products and Food Science Program, Division of Animal Applied Science, College of Animal Life Sciences, Kangwon National University, Chuncheon 24341, Republic of Korea

[2] Department of Animal Science and Technology, Konkuk University, Seoul 05029, Republic of Korea

[*]Corresponding author email: kihoback@naver.com

Abstract – The objective of this study was to identify the effects of induced-molting in spent layer on physicochemical and sensory properties of breast meat. Three different types of breast samples were prepared: Commercial broiler (Arbor acre; 6 weeks), not-molting spent layer (Hy-line; 75 weeks), and molting spent layer (Hy-line; 90 weeks). The broiler showed the highest water holding capacity and the lowest cooking loss value ($p<0.05$), while no significant differences were found between not-molting and molting treatments ($p>0.05$). The breast meat of molting spent layer, contained the highest total collagen and showed the highest shear force value ($p<0.05$). In case of the sensory evaluation, especially for cooked meat, there were no significant differences between not-molting and molting treatments ($p<0.05$). For fatty acid composition, there were no significant differences in saturated fatty acid (SFA) and polyunsaturated fatty acid (PUFA) between not-molting and molting spent layer ($p>0.05$). The n-6/n-3 value was significantly higher in spent layer than broiler ($p<0.05$), however, no differences were observed between not-molting and molting ($p>0.05$). As a result, except texture, there are no big differences for meat quality between not-molting and molting treatments. So, feeding molt spent layer had equivalent potential as raw materials with commercial spent layer.

Key Words – Fatty acid composition, sensory evaluation, texture profile

I. INTRODUCTION

The usage of chicken meat has increased to produce various chicken-based meat products [1], and especially chicken breast, which has demonstrated increasing consumer sales and is a white meat, has many advantages compared with other red meats [2]. Because of this trend, despite being less tender than broiler meat, the consumption of spent layer, especially by using at the end of a laying cycle as a raw material, has increased [3]. Moreover, because of their depreciation or market price, many poultry industries conduct some molt feeding for spent layer. However, they are concerning about induced-molting in spent layer which have the possibility to lead to poor meat quality (i.e., color, tenderness, fatty acid composition etc.) as raw materials. So, the objective of this study was to identify the effects of induced-molting in spent layer on physicochemical and sensory properties of breast meat to find way to optimize the molt feeding spent layer meats.

II. MATERIALS AND METHODS

Materials

Three different types of breast samples were prepared. Each 10 Commercial broiler (Arbor acre; 6 weeks of age) and spent layer (Hy-line, not-molting 75 weeks of age; Hy-line, molting 90 weeks of age) were purchased from JUNG-WOO-FOOD Agricultural Company (Korea).

Color evaluation

The surface color of each sample was determined by using chroma-meter (CR-400, Konica Minolta Sensing Inc., Osaka, Japan) measuring lightness (CIE L*-value), redness (CIE a*-value) and yellowness (CIE b*-value); illuminate C was calibrated with a white standard plate (Y= 93.6, X=0.3134, y= 0.3194). The color measurement was performed 8 times in each sample.

pH

A homogenizer (PH-91, SMT Co., Japan) was used to homogenize 5 g of sample in 50 mL of distilled water for 1 min at 10,000 rpm. The pH value was recorded using a pH meter (SevenEasy pH, Mettler-Toledo GmbH, Schwerzenbach, Switzerland).

Cooking loss

Three breast meat samples (weight 100 ± 10 g) were covered with aluminum foil and placed in a polypropylene bag and cooked using a water bath (BW-20G, Jeio Tech Co., Daejon, Korea) at 80 °C for 30 min. These samples were cooled to room temperature for 30 min, and cooking loss was determined by calculating the weight differences before and after cooking.

Water holding capacity (WHC)

The water holding capacity (WHC) was measured in triplicate using the Choi *et al.* [4] method and Laakkonen *et al.* [5] method with slight modifications. First, a sieve (4 × 4 cm, 19 mesh) was put in the middle of a specially formed centrifuge tube. Approximately 10 g of meat samples were then placed on the sieve, and covered with aluminum foils. Samples were cooked at 75 °C for 30 min in a water bath and then centrifuged at 1,000 rpm for 10 min at 4 °C. Aluminum foil and meat samples were then discarded, and each tube was determined by weight change after 24 h at 100 °C. The WHC was measured by calculating the percentage of the total moisture and the water loss.

Shear force and texture profile analysis (TPA)

The Warner-Bratzler shear force (WBSF) and the texture profile analysis (TPA) were performed at room temperature using a texture analyzer (TA-XT2i, Stable Micro Systems Ltd., Goldalming, Surrey, England). Ten cubed (1 × 1 × 1 cm; width × length × height) samples taken from the central portion of each cooked meat were kept to equilibrate to room temperature. The shear force (WBSF) values were determined using a 3 mm Warner-Bratzler shear blade. The texture analysis conditions were as follows: pre-test speed 2.0 mm/s, post-test speed 5.0 mm/s, maximum load 2 kg, head speed 2.0 mm/s, distance 8.0 mm, force 5 g.

Sensory evaluation

Two types of sensory evaluation, for uncooked and cooked breast meat samples, were performed with three batches at the same condition. Uncooked meat samples were evaluated for color, aroma, and overall acceptance. While, cooked meat samples were evaluated for color, flavor, juiciness, tenderness and overall acceptance. 15 trained panelists evaluated using on a 9-point hedonic scale: 1-most unpleasant, very unpleasant, moderately unpleasant, slightly unpleasant, neither pleasant nor unpleasant, slightly pleasant, moderately pleasant, 9-most pleasant. Panelists were presented with randomly coded samples and required to cleanse their palate with water between samples.

Total collagen and fatty acid composition

Total collagen was determined using Kolar's method [6] with slight modifications. 30 mL of 7 N H_2SO_4 was added to 4 g of breast meat samples, and then hydrolyzed at 105 °C for 16 h. Distilled water was added to a total volume of 500 mL, filtering with filter paper. 100 mL of distilled water was added to 50 mL of Filtrate. 1 mL of oxidating solution was added to 2 mL of filtrate with vortexing, and then left at room temperature for 20 min. 1 mL of color reagent was added to samples, covered with cap and placed in a water bath at 60 °C for 15 min. Samples were cooled with running water for 3 min, and then measuring for 550 nm absorbance. Fatty acid composition was determined using a gas chromatography (YL6500, YL Instrument, Korea). The lipid fraction of the meat sample, extracted according to Folch *et al.* [7] with chloroform-methanol (2:1 v/v). Samples were methylated as described by AOAC [8]. One μL of sample was injected into the column in the split mode (100:1). Fatty acid methyl esters were separated using a Wcot fused silica capillary column (#CP7489, 100 m × 0.25 mm i.d., 0.2 μm film thickness; Varian, Inc., USA) with a 1 mL/min of helium flow. The oven temperature was increased; 150 to 200 °C at 15 °C/min, 200 to 250 °C at 5 °C/min. Temperatures of the injector and detector were 275 °C. The fatty acid peaks were identified and quantified by comparing with the retention time and peak area of fatty acid standards (Supelco 47015-U, USA).

Statistical analysis

Other data were subjected to one-way ANOVA using R-version 3.1.2 with "Agricolae" library (The R-foundation for Statistical Computing, Austria). The statistical significance of the differences between means from different treatments was determined by Duncan's multiple range test ($p<0.05$).

III. RESULTS AND DISCUSSION

The results of the physicochemical properties among the samples are presented in Table 1. The pH of the broiler was significantly higher than for the other treatments ($p<0.05$). However, there were no significant differences between not-molting and molting treatments ($p>0.05$). In this connection, broiler showed the highest water holding capacity ($p<0.05$) and the lowest cooking loss value ($p<0.05$), while no significant differences were found between not-molting and molting treatments ($p>0.05$). Similar results were reported by Chuaynukool *et al.* [9] in which, for pectoralis major, the pH of broiler (commercial broiler; *CP707*, 38 days) was significantly higher than spent layer (*H and M Brown Nick*, 52 weeks), and the results for cooking loss exhibited a reversed pattern.

The lightness (CIE L^*) of the not-molting treatment was significantly higher than that of other treatments ($p<0.05$), and the molting treatment had the highest redness (CIE a^*) value ($p<0.05$).

Total collagen in meat related to tenderness. Spent hen muscles, especially feeding molting, contained the highest total collagen ($p<0.05$). So, molting treatment showed the highest shear force value ($p<0.05$). Although the broiler and not-molting treatments have similar total collagen contents, higher shear force and hardness values were presented for not-molting treatment than broiler ($p<0.05$). This was probably related to proportion of soluble collagen which was contained in lower rate for not-molting treatment than broiler. Spent hen also had high gumminess and chewiness values compared to broiler ($p<0.05$).

Table 1 Physicochemical properties of spent layer breast meat compared with broiler

Parameter	Treatments[1]			SEM
	Broiler	Not molting	Molting	
pH	6.10^{a}	5.84^{b}	5.77^{b}	0.06
Cooking loss (%)	22.8^{b}	31.8^{a}	34.0^{a}	1.78
WHC (%)	73.1^{a}	69.0^{a}	60.1^{b}	2.55
Lightness (L^*)	52.3^{b}	57.6^{a}	54.1^{b}	0.79
Redness (a^*)	1.16^{b}	2.18^{b}	3.91^{a}	0.39
Yellowness (b^*)	3.37^{b}	6.53^{a}	6.00^{a}	0.59
Total collagen (mg/g)	1.20^{b}	1.41^{b}	3.45^{a}	0.29
Shear force (kg)	1.79^{c}	3.39^{b}	4.30^{a}	0.26
Hardness (kg)	11.9^{b}	21.8^{a}	21.8^{a}	1.62
Gumminess (kg)	3.43^{b}	8.00^{a}	8.58^{a}	0.83
Chewiness (kg)	1.83^{b}	4.79^{a}	5.35^{a}	0.57

SEM, standard error of the means; $^{a\text{-}c}$ means within each row with different superscripts are significantly different ($p<0.05$).
[1] Broiler: Arbor Acre (6 weeks of age), Not molting: Hy-line (75 weeks of age), Molting: Hy-line (90 weeks of age).

The sensory evaluation results are also shown in Table 2. For raw meat, significant differences were observed in color and overall acceptance among treatments ($p<0.05$). The broiler treatment had the highest color and overall acceptance score than the other treatments ($p<0.05$). Within spent layer, not-molting treatment had a higher score than molting treatment ($p<0.05$). For cooked meat, the broiler treatment also had a higher flavor, juiciness, tenderness, and overall acceptance score than spent layer treatments ($p<0.05$). However, there were no differences between not-molting and molting treatments ($p>0.05$).

Table 2 Sensory evaluation of spent layer breast meat compared with broiler

Parameter	Treatments[1]			SEM
	Broiler	Not molting	Molting	
Raw meat				
Color	8.46^{a}	7.15^{b}	6.62^{c}	0.16
Aroma	8.60	8.33	8.20	0.11
Overall acceptance	8.62^{a}	7.62^{b}	6.85^{c}	0.17
Cooked meat				
Color	8.60	8.20	7.60	0.18
Flavor	8.20^{a}	6.60^{b}	6.40^{b}	0.25
Juiciness	8.30^{a}	5.80^{b}	5.20^{b}	0.36
Tenderness	8.30^{a}	5.50^{b}	5.20^{b}	0.35
Overall acceptance	8.50^{a}	6.70^{b}	6.10^{b}	0.26

SEM, standard error of the means; $^{a\text{-}c}$ means within each row with different superscripts are significantly different ($p<0.05$).
[1] Broiler: Arbor Acre (6 weeks of age), Not molting: Hy-line (75 weeks of age), Molting: Hy-line (90 weeks of age).

The fatty acid composition of treatments is given in Table 3. The highest saturated fatty acids (SFA) were observed in molting treatment ($p<0.05$). However, the PUFA content of broiler treatment was significantly lower than for the other treatments ($p<0.05$). The highest oleic acid was observed in broiler treatment ($p<0.05$). The ratios of the omega-6 to omega-3 fatty acids were significantly higher in spent layer treatments than broiler treatment ($p<0.05$), however, no differences were observed between not-molting and molting treatments ($p>0.05$).

Table 3 Fatty acid profile of spent layer breast meat compared with broiler

Fatty acid	Treatments[1]			SEM
	Broiler	Not molting	Molting	
C14:0	1.03 [a]	0.70 [b]	0.77 [b]	0.06
C16:0	26.2 [b]	26.1 [b]	28.0 [a]	0.39
C16:1n7	4.40 [a]	1.47 [b]	1.27 [b]	0.51
C18:0	8.27 [b]	9.10 [a]	9.43 [a]	0.18
C18:1n9	35.8 [a]	31.3 [b]	27.7 [b]	1.29
C18:2n6	18.1 [c]	22.0 [a]	20.1 [b]	0.58
C18:3n6	0.83 [a]	0.40 [b]	0.37 [b]	0.08
C18:3n3	0.90 [a]	0.53 [b]	0.47 [b]	0.08
C20:4n6	2.80 [c]	7.10 [b]	10.2 [a]	1.10
C20:5n3	0.47 [a]	0.10 [b]	0.10 [b]	0.06
C22:4n6	0.77 [b]	0.90 [b]	1.17 [a]	0.06
C22:6n3	0.50 [a]	0.30 [c]	0.40 [b]	0.03
SFA	35.5 [b]	35.9 [b]	38.2 [a]	0.52
UFA	64.6 [a]	64.1 [a]	61.8 [b]	0.51
MUFA	40.2 [a]	32.8 [b]	29.0 [c]	1.72
PUFA	24.4 [b]	31.3 [a]	32.8 [a]	1.33
PUFA/SFA	0.69 [b]	0.87 [a]	0.86 [a]	0.03
n-3	1.88 [a]	0.93 [b]	0.97 [b]	0.16
n-6	22.5 [b]	30.4 [a]	31.8 [a]	1.48
n-6/n-3	12.2 [b]	32.7 [a]	33.0 [a]	3.52

SEM, standard error of the means; [a-c] means within each row with different superscripts are significantly different ($p<0.05$).
[1] Broiler: Arbor Acre (6 weeks of age), Not molting: Hy-line (75 weeks of age), Molting: Hy-line (90 weeks of age).

IV. CONCLUSION

Although tougher instrumental texture and higher content of collagen were affected by molting, there are no big differences for sensory attributes and fatty acid composition between not-molting and molting treatments. So, for processed meat product, the breast meat of molting had similar potential with commercial spent layer as raw materials.

ACKNOWLEDGEMENTS

This research was supported by Export Promotion Technology Development Program, Ministry of Agriculture, Food and Rural affairs, Republic of Korea.

REFERENCES

1. Silva, C. M. G. & Glória, M. B. A. (2002). Bioactive amines in chicken breast and thigh after slaughter and during storage at 4±1°C and in chicken-based meat products. Food Chem. 78:241-248.
2. Kim, H. W., Choi, M. S., Hwang, K. E., Song, D. H., Kim, Y. J., Ham, Y. K., Chang, S. J., Lim, Y. B., Choi, Y. S. & Kim, C. J. (2014). Effect of mixing ratio between pork loin and chicken breast on textural and sensory properties of emulsion sausages. Korean J. Food Sci. An. 34:133-140.
3. Souza, K. M. R., Araujo, R. B., Santos, A. L., Rodrigues, C. E. C., Faria, D. E. & Trindade, M. A. (2011). Adding value to the meat of spent laying hens manufacturing sausage with a healthy appeal. Braz. J. Poultry. Sci. 13:57-63.
4. Choi, Y. S., Lee, M. A., Jeong, J. Y., Choi, J. H., Han, D. J., Kim, H. Y., Lee, E. S. & Kim, C. J. (2007). Effects of wheat fiber on the quality of meat batter. Korean J. Food Sci. An. 27:22-28.
5. Laakkonen, E., Wellington, G. H. & Sherbon, J. W. (1970). Low-temperature, long-time heating of bovine muscle. I. Changes in tenderness, water-binding capacity, pH and amount of water soluble components. J. Food Sci. 35:175-177.
6. Kolar, K. (1990). Colorimetric determination of hydroxyproline as measure of collagen content in meat and meat products: NMKL collaborative study. J. AOAC Int. 73(1):54-57.
7. Folch, J. M., Lee, M., Sloan, G. H. (1957). A simple method for the isolation and purification of total lipids from animal tissues. J. Biol. Chem. 226: 497-514.
8. AOAC (1995). Official Methods of Analysis 4 16th ed. Associationof Official Analytical Chemists, Arlington, pp. 1–45.
9. Chuaynukool, K., Wattanachant, S. & Siripongvutikorn, S. (2007). Chemical and physical properties of raw and cooked spent hen, broiler and thai indigenous chicken muscles in mixed herbs acidified soup (tom yum). J. Food Technol. 5(2):180-186.