RELATIONSHIP BETWEEN THE COOKING CONDITIONS AND QUALITY CHARACTERISTICS OF *TTEOKGALBI* (KOREAN TRADITIONAL PATTY) MADE FROM SPENT LAYING HEN MEAT

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Abstract – Patties were made from spent laying hen meat under different cooking conditions. For treatments 1 and 2 (T1 and T2), the samples were cooked in an oven at 180°C/15 min and 90°C/30 min, respectively. The treatments T3 and T4 included frying the samples first at 180°C/40 s, and then cooking at 180°C/10 min or at 90°C/20 min in the oven, respectively. The ash content was higher in the fried and cooked samples than in the cooked-only samples. There was no difference in the total colony counts among the treatment samples. Cooking loss was the highest in the T4 samples. Fried samples showed lower Hunter L* and higher a* values compared to those of the non-fried samples. These differences were more prominent in the T3 samples than in the T4 samples. The T3 samples scored highest in sensory evaluation among the four types of cooking conditions tested.

Key Words – Cooking condition, patty, spent laying hen meat

I. INTRODUCTION

Tteokgalbi is a Korean traditional meat patty that is prepared according to different region-specific recipes and preparation methods. Consumer preference for chicken meat is increasing because of its higher nutritional values, higher unsaturated fatty acid and protein contents, and lower cholesterol contents compared to those of red meats [1, 2]. In industrialized countries, spent laying hen meat is used in the manufacture of pet foods, livestock feed, concentrated stock, soups, and stews [3]. There have been many attempts to use spent laying hen meat for production of various meat and meat-containing products such as mortadella-like sausage using vegetable oil [4], sausage made with spent laying hen surimi [5], popped cereal snacks [6], and patties [7]. Low emulsifying capacity, water binding capacity, and salt soluble protein content of spent laying hen meat are the main limitations for its usage in meat production [8]. However, its tough texture and low palatability might not be problematic for the comminuted products like ground or emulsion type sausage [9]. The effects of different cooking methods on the quality characteristics of ground patties have been investigated. Pan-frying was superior to broiling for the juiciness and flavour of ground beef patties. However, palatability scores were similar between broiled and microwaved patties [10]. Broiling resulted in higher cooking losses of beef patties compared to those cooked by pan-frying [11]. In this study, we examined the effects of cooking temperature and time, and frying treatment prior to oven cooking on the various quality characteristics of *Tteokgalbi* patties made from spent laying hen meat.

II. MATERIALS AND METHODS

Frozen spent hen carcasses (approx. 18 months old and 1.8 kg in wt) were purchased from a local supplier (Yujin, Korea). After thawing in a 10°C refrigerator for 24 h, they were deboned and dressed by hand. Frozen pork back fat was thawed similarly. They were then ground using a chopper (PM-82, Manica, Spain) with a 5-mm plate attachment. Fresh garlic, welsh onion, and ginger were chopped to the approximate size of 0.2 cm x 0.2 cm. Ground meat and pork back fat were thoroughly mixed in a mixer, (KM230, KENWOOD, Britain) followed by the addition of other ingredients and then mixing for another 2 min, maintaining the temperature throughout below 10°C by the addition of ice water. The recipe of the patties comprised spent laying hen meat (54.4%), pork back fat (14.3%), bread crumbs (2.8%), salt (0.2%), ice water (10.8%), phosphate (0.1%), ascorbic acid (0.1%), MSG (0.2%), and other spices and seasonings (sugar,

seasonings, soy sauce, garlic, welsh onion, and ginger; 17.1% in total). The mixed samples were apportioned into 100-g aliquots, wrapped in a polyethylene film (thickness 0.01 mm, size 20 cm x 20 cm) and formed into patties (approx. 100 mm dia. and 15 mm thickness) by pressing in a mould (Burger Press, Spikomat Co., UK). The formed patties were placed in a freezer at -18°C for 1 h for holding the shape. For the treatments T1 and T2, the patties were cooked in an oven (FDO 7102, Daeyoung Co., Korea) at 180°C for 15 min or 90°C for 30 min, respectively. For the treatments T3 and T4, the patties were first fried for 40 s in a corn oil bath at 180°C and then cooked at 180°C for 10 min or at 90°C for 20 min, respectively, in the oven. The surface and core temperatures of patties were monitored using a thermocouple (Multi-Thermo, DAIHAN, Korea). In each treatment, the cooking was complete when the core temperature of the patties reached 72°C. The initial relative humidity of the oven was read at 40−45% and the air circulation speed was 0.5 m/s. The cooked patties were chilled in a 5°C-refrigerator for 30 min. The patties were then packaged in a polyamide/polyethylene film (O_2 permeability; 40 ml/m^2/day/atm) using a vacuum packaging machine (Quick 7G, Hansung Co., Korea). The packaged samples were stored in a 0°C-refrigerator until they were allocated for further experiments. Moisture, crude fat, crude protein, and crude ash contents were analysed according to the Association of Analytical Communities (AOAC) method [12]. The pH of the patties was determined using a pH meter (SG2-ELK, Mettle Toledo Co., Ltd., Switzerland) after 10 g of the sample was ground with 40 ml distilled water using a blender (WF-2211214, Waring, USA). The content of thiobarbituric acid reactive substances (TBARS) in the patties was determined according to Witte's method [13] as an indicator of fat oxidation index. Hunter L^* (lightness), a^* (redness), b^* (yellowness) colour values were measured for the patties (3 x 3 cm) using a colorimeter (CR-300, Minolta Co., Japan) after calibrating with a standard white plate (L^*= 98.59, a^*= 0.09, and b^*= 0.37). Total aerobic colonies on a standard plate count agar (Oxoid, UK) were counted after incubating at 30°C incubator for 2 days. The difference between the weight before and after cooking was calculated to determine the cooking losses. The cooked patty samples were weighed after cooling for 5 min at room temperature after the cooking process was completed. Hardness and springiness values of samples were measured using a rheometer (Compac-100 II, Sun Scientific, Japan) with the attachment of adaptor No. 19 at a speed of 60 mm/min. The samples were prepared by cutting into regular hexahedron shapes measuring approximately 2 x 2 x 2 cm. Ten panellists from Food Packaging Laboratory, experienced in the quality assessment of meat products, evaluated the sensory properties of the samples for appearance, texture, flavour, and odour using a 9-point hedonic scale. Data were analysed using a Statistical Analysis Systems software (SPSS, Version 21 software, IBM, USA) and statistical significance at $p<0.05$ was examined by Duncan's multiple range tests.

III. RESULTS AND DISCUSSION

Table 1 shows the effect of different cooking conditions on the proximate composition of patties made from spent laying hen meat. The water, crude protein, and crude fat contents were significantly different among samples ($p>0.05$). However, the ash content of the T3 and T4 samples (1.60%) was measured to be significantly higher than those of T1 (1.36%) and T2 (1.48) ($p < 0.05$). This result indicates that the frying process has slightly increased the ash content of samples compared to that of the non-fried samples.

Table 1. Proximate composition of *Tteokgalbi* made from spent laying hen meat

Parameter	Treatments[1)]			
	T1	T2	T3	T4
Moisture	61.30 ±0.66[a]	59.16 ±1.80[a]	60.66 ±1.09[a]	60.41 ±0.35[a]
Crude protein	24.09 ±0.38[a]	23.48 ±0.73[a]	24.25 ±0.39[a]	24.06 ±0.54[a]
Crude fat	14.60 ±0.76[a]	14.33± 0.18[a]	13.56 ±0.92[a]	13.64 ±0.97[a]
Crude Ash	1.36 ±0.04[c]	1.48± 0.04[b]	1.60 ±0.07[a]	1.60 ±0.07[a]

[1)] T1: Cooked at 180℃/15 min, T2: Cooked at 90℃/30 min, T3: Fried at 180℃/40 s- cooked at 180℃/10 min, and T4: Fried at 180℃/40 sec- cooked at 90℃/20 min

[a-c] Means with the different superscripts within the same column are significantly different ($p<0.05$).

The L^* values differed significantly and were in the order of T1 > T2 > T3 > T4 ($p<0.05$). The L^* values were significantly decreased by the frying process in the T3 and T4 samples compared to the T1 and T2 samples ($p<0.05$) (Table 2). The samples cooked at higher temperature, the T1 and T3 samples, were significantly brighter than those cooked at lower temperature, the T2 and T4 samples. The a^* values were the highest in the T4 samples, and were in the order of T3 > T2 = T1 ($p<0.05$). Fried samples (T3 and T4) showed higher a^* values than the non-fried samples (T1 and T2). The b^* values of T3 samples were significantly higher than those of the others ($p<0.05$), presumably because of the frying process and high cooking temperature.

Table 2. Instrumental colour parameters of *Tteokgalbi* made from spent laying hen meat

Color parameter	Treatments[1)]			
	T1	T2	T3	T4
Hunter L^*	52.53 ±0.94[a]	44.64 ±1.50[b]	41.63 ±2.03[c]	34.42 ±1.53[d]
a^*	3.19 ±0.27[c]	3.14 ±0.30[c]	5.75± 0.68[b]	6.88 ±0.61[a]
b^*	11.26 ±0.42[b]	11.08 ±0.57[b]	12.21 ±0.45[a]	10.71 ±0.85[b]

[1)] For details, please refer to Table 1.
[a-b] Means with the different superscripts within the same column are significantly different ($p<0.05$).

The total aerobic colony counts were in the range of 3.15–3.26 and 3.57–3.75 log cfu/g in the fried and non-fried samples, respectively ($p>0.05$) (Table 3). This result implies that the microbial burden of the final product might primarily be the result of secondary contamination after cooking and during packaging process, although frying process could further reduce the microbial counts compared to the only cooked samples.

Table 3. Total aerobic counts of *Tteokgalbi* made from spent laying hen meat

Parameter	Treatment[1)]			
	T1	T2	T3	T4
Total aerobes (log cfu/g)	3.75± 0.03	3.57± 0.09	3.26± 0.06	3.15± 0.02

[1)] For details, please refer to Table 1.

The cooking loss was significantly higher in the T4 samples compared to that in the other samples ($p<0.05$) (Table 4). Cooking at lower temperature and longer time (90°C/20 min) after frying (T4) increased the cooking loss significantly compared to cooking at a higher (180°C) temperature and a shorter time (10 min) (T3), despite the slight weight gain resulting from frying in vegetable oil. This might be attributed to the evaporation higher water content during cooking for a longer duration.

Table 4. Cooking loss of *Tteokgalbi* made from spent laying hen meat

Parameter	Treatments[1)]			
	T1	T2	T3	T4
Cooking loss	30.30 ±1.87[b]	31.19 ±1.31[b]	31.13 ±0.68[b]	34.17 ±0.43[a]

[1)] For details, please refer to Table 1.
[a-b] Means with the different superscripts within the same column are significantly different ($p<0.05$).

The texture profiles such as hardness and springiness are presented in Table 5. The hardness value was the highest in the T2 sample compared to that of the others ($p<0.05$). Moreover, the T2 samples had the highest springiness value compared to the T3 and T4 samples ($p<0.05$).

Table 5. Hardness and springiness of *Tteokgalbi* made from spent laying hen meat

Parameter	Treatments[1)]			
	T1	T2	T3	T4
Hardness (kg/㎡)	1,594.8 ±33.5[b]	1,629.4 ±5.5[a]	1,586.6 ±8.0[b]	1,589.9 ±11.5[b]
Springness (%)	82.7 ±3.0[ab]	84.7 ±2.0[a]	79.8 ±1.5[b]	80.5 ±1.8[b]

[1)] For details, please refer to Table 1.
[a-b] Means with the different superscripts within the same column are significantly different ($p<0.05$).

The outer appearance score was the highest in the T3 samples, followed by the T4, T2, and T1 samples in that order (Table 7). It was generally higher in the fried samples of T3 (8.4) and T4 (7.7) compared to in cooked only samples, T1 (7.1) and T2 (7.3). Flavour scores were significantly lower in the T2 samples compared to other samples ($p<0.05$). The scores for texture and odour were not significantly different among the samples. Overall, the T3 patties were

evaluated to be superior to those cooked under the other experimental conditions.

Table 6. Sensory test of *Tteokgalbi* made from spent laying hen meat

Parameter	Treatments[1)]			
	T1	T2	T3	T4
Appearance	7.1 ±0.9[b]	7.3 ±0.5[b]	8.4 ±0.6[a]	7.7 ±0.4[ab]
Off-odour	8.0 ±0.8	8.1 ±0.7	8.5 ±0.5	8.3 ±0.8
Texture	7.8 ±0.4	8.1 ±0.5	7.9 ±0.9	7.8 ±0.8
Flavour	8.1 ±0.2[a]	8.0 ±0.5[b]	8.2 ±0.6[a]	8.1 ±0.4[a]

[1)] For details, please refer to Table 1.
[a-b] Means with the different superscripts within the same column are significantly different ($p<0.05$).

IV. CONCLUSION

For the production of *Tteokgalbi* patties made from spent laying hen meats, an initial frying treatment at 180°C for a brief duration (40 s) followed by cooking at high temperature (180°C) for a short time (10 min) is recommended for the best red and yellow values, and sensory attributes.

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