

Effect of Pre-cooking Conditions on the Quality Characteristics of Ready-To-Eat *Samgyetang*

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Abstract

The aim of this study was to examine the effectiveness of pre-cooking conditions on the quality characteristics of ready-to-eat (RTE) *Samgyetang*. Raw chickens were steamed under the different conditions of 50°C/30 min (T1), 65°C/30 min (T2), 85°C/30 min (T3), and 90°C/10 min (T4) prior to retorting at 120°C for 65 min. The results showed that pre-cooking conditions in all treated samples could reduce fat contents in breast and leg meats by 8.5-11.7% and 10.0-11.0% compared to the control, even though there were no significant differences among treatments ($p>0.05$). The L^* and b^* values of breast and leg meats treated with the higher temperature and longer time conditions were significantly higher than the control ($p<0.05$), while a^* values tended to decrease despite of not to a significant extent ($p>0.05$). Moreover, apparent viscosity and water soluble protein showed insignificant differences ($p>0.05$) among the samples as a result of the retorting process, which might have more negative influences on the quality. T2 samples obtained significantly the highest average Quantitative Descriptive Analysis (QDA) score and transmittance value, representing the most clear broth among the samples, compared to the control. On the other hand, T3 showed the highest cooking loss among the treatments and the lowest QDA scores among the samples. In conclusion, pre-cooking treatment prior to retorting in manufacturing *Samgyetang* is a plausible way to reduce its fat content. A pre-cooking condition at either 65°C for 30 min, or 90°C for 10 min are recommended for producing *Samgyetang* with optimum quality.

Keywords: *Samgyetang*, ready-to-eat, pre-cooking condition, quality characteristic

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Introduction

Modern dietary expectations are emerging as a reflection of changing lifestyles, and nowadays consumers increasingly tend to seek out nutritious and functional foods. *Samgyetang* is a Korean traditional favorite chicken soup containing ginseng, oriental medicinal herbs, and is popular as a dietary choice. In Korea, *Samgyetang* is a summer time favorite because it is considered to prevent illness and to supplement nutrients lost through excessive sweating and physical activity (Suzuki and Rhim, 2000). Korean *Samgyetang* has been exported to Japan, Taiwan, Hongkong, and Australia to a tune of approximately 15 million dollars a year (KMTA, 2013).

Today's busy lifestyles have led to an increased consumption of ready-to-eat (RTE) products which can be conveniently prepared (Murcia *et al.*, 2003). *Samgyetang*

has been developed as an RTE product so people can fit a nutritional meal into a busy schedule (Jang and Lee, 2012). RTE *Samgyetang* consists of two main parts: a whole chicken and an accompanying broth. The abdominal cavity of the chicken contains porridge, ginseng, garlic, chestnut, and jujube. It is stored at ambient temperature, and can be prepared and served quickly and simply either by microwaving for 5 to 10 min, or by heating in boiling water for 15 to 20 min.

Current efforts to improve the quality of *Samgyetang* require technological approaches to reduce the fat content, not only improving the product's healthiness, but importantly its visual appeal. Pre-cooking the raw chicken before retorting has been proposed as a method for *Samgyetang* manufacturers to decrease the fat content of the chicken meat, as well as to improve the quality characteristics of *Samgyetang* products. This technique uses high-temperature steam to transport moist heat onto the raw chicken meat in order to melt the fat out above its boiling point. Recently, some Korean *Samgyetang* factories have begun to apply pre-cooking treatments mostly at 85°C for 30 min to reduce the fat content of the raw

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chicken meat before retorting. Pre-cooking is generally being used to extend the shelf life of some food products which are simple in process and low cost (Manheem *et al.*, 2013). However, temperatures and exposure times were decided on the basis of experience, rather than on the basis of scientific research. Moreover, there has been little reported about the effects of pre-cooking chicken before retorting *Samgyetang* products. This study therefore evaluated the effectiveness of various pre-cooking conditions for RTE *Samgyetang*, with a view to reducing its fat content and improving its quality characteristics.

Materials and Methods

Sample preparation

The RTE *Samgyetang* used for the experiment was manufactured in the Packaging Laboratory of Gangneung-Wonju National University and the Gangneung Industrial Complex, Korea. Eighty Korean broiler chickens (450 g) raised with the same feeding method for 14 d were slaughtered by a commercial chicken company (Harim, Korea) and then chilled overnight for use in the experiment. The carcasses were obtained and transported to the laboratory in a chilled state (below 5°C). Pre-cooking was done by steaming raw chickens using a steam oven (FX61E1, Angelo Po, Italy) set at 85% RH. The steaming temperature and time conditions applied were as follows: control/without pre-cooking (C), 50°C/30 min (T1), 65°C/30 min (T2), 85°C/30 min (T3), and 90°C/10 min (T4). These conditions were based on preliminary experimental results, and determined in relation to current factory standards, including 85°C/30 min, which is commonly used in the industry. The use of lowest temperature condition of 50°C was because it is the minimum required temperature to melt chicken fat in the process line as reported by Piette *et al.* (2001). The T4 option (involving a shorter exposure time) was applied in recognition of the needs of the *Samgyetang* industry to produce on a mass-scale at speed. Broth was prepared by boiling water with chicken powder, chicken meat, garlic, ginger, chestnut, salt, milk vetch root, pepper, and sugar for 2 h while removing foam and fat droplets from the surface of the broth. Each pouch of *Samgyetang* consisted of a Korean broiler chicken, with the abdominal cavity stuffed with 100 g rice, 100 g ginseng-garlic-chestnut-jujube, and an added 200 mL of broth. The retort pouch consisted of a multilayer plastic film (PET 12 µm/AL 9 µm/PA 15 µm/PP 100 µm) and was heat-sealed using a sealer (XP 300, Prepac S.A., Greece). Packaged samples were then sterilized in a retort machine

(PRS-06-1, Kyonghan Co., Ltd., Korea) at 120°C for 65 min under the F-value of approximately 8.0. Selected samples were checked for integrity at least three days after the retorting process. The analysis was repeated three times, and one pack of retorted *Samgyetang* was used for a maximum of three analyses.

pH value

The pH measurement was performed on both breast and leg meat, and on the broth, using the method described by Muhlisin *et al.* (2013). Ten grams of chicken meat was added into 40 mL of distilled water, and then homogenized at 10,000 rpm for 60 s using a homogenizer (T 18 Ultra-Turrax, IKA, Germany). The pH values of homogenized sample and the broth were measured using a pH meter (Sg2-ELK, Mettler Toledo Co., Ltd., USA) attached with a spear-type electrode. The pH measurement was performed in triplicate per treatment.

Cooking loss

The cooking loss was assessed using the method described by Wattanachant *et al.* (2004) with some modifications. Whole chicken meats were weighed by using an electronic balance (CUX4200H, CAS Corp., USA) with readability of 0.01 g before and after pre-cooking treatments. Briefly, the initial weights of the uncooked samples were recorded, and then pre-cooked under the various conditions at 85% RH. Samples were then immediately cleaned using a wipers paper (Wypall L25, Yuhan Co., Ltd., Korea) straight from the steam oven (FX61E1, Angelo Po, Italy) to remove the water and debris from the meat. Cooking loss was calculated on each of the whole chicken as follows:

$$\text{Cooking loss (\%)} = \frac{\begin{array}{l} \text{The weight of chicken} \\ \text{before pre-cooking (g)} \\ - \text{The weight of chicken} \\ \text{after pre-cooking (g)} \end{array}}{\begin{array}{l} \text{The weight of chicken} \\ \text{before pre-cooking (g)} \end{array}} \times 100$$

Instrumental color

The instrumental colors on *Samgyetang* were measured according to the method described by Jang and Lee (2012) on the breast meat, leg meat, and broth. Color changes on the surface of chicken breast and leg meats of *Samgyetang* were monitored by measuring the CIE lightness (L*), redness (a*), and yellowness (b*) using a color difference meter (CR-400, Konica Minolta Sensing Inc., Japan). The color instrument was calibrated using a white plate (Y =

93.7, $x = 0.3132$, and $y = 0.3192$). Illuminant C and standard 10 observer were used for measuring color characteristics. Color measurements were directly performed on the surface of breast and leg meats after removing the chicken skin. Color of breast and leg meats was measured six times in each sample at different locations. The broth color was evaluated using a color meter (JS555, Color Techno System Co., Japan) according to the method of Aramwit *et al.* (2010) from the solution color after separating the debris with a 500- μm sieve.

Texture profile

Texture profile of *Samgyetang* was performed six times in every treatment on the breast meat using the method described by Chung (2010) with some modifications. The breast meats were cooled at room temperature for 1 h, and cut into 1.5 cm \times 1.5 cm \times 0.5 cm using a surgical blade (Surgical Blade Stainless No. 11, Feather Safety Razor Co., Ltd., Japan). The textural properties of each piece of breast meat was measured with a spherical probe (No. 2), attached to a rheometer (Compac-100, Sun Scientific Co., Ltd., Japan) with RDS 2.01 software. The compression probe was set to 20 mm at initial height, probe speed at 2 mm/s, graph interval at 30 m/s, and load cell at max. 2 kg. Texture profile was expressed as hardness (kg/m^2), cohesiveness (%), springiness (%), gumminess (kg), and brittleness (kg).

Transmittance

Transmittance value in this study was important to measure the clarity of *Samgyetang* broth which is affected by the presence of fat droplets extracted from chicken meats during precooking process. Transmittance of broth was measured using a spectrophotometer (S-3100, Scinco Co., Ltd., Korea). The sample was separated by a 350- μm sieve and centrifuged at $3,000 \times g$ for 5 min using a centrifuger (Gyrozen 416G, Gyrozen Co., Ltd., Korea). The absorbance of supernatant was measured at 600 nm wavelength. Transmittance was assessed from the percentage of light which passed through the solution. The measurement of transmittance was calculated as follows:

$$\%T = \frac{I_i}{I_o} \times 100$$

I_i = Remaining light

I_o = Initial light

Proximate composition

Proximate composition was determined on the breast

and leg meats, and the broth according to the AOAC method (AOAC, 2007). The moisture contents of meat and broth of *Samgyetang* were determined by heating the sample at 105°C in a drying oven (KI-012, Kum Hwa Industrial Co., Korea). The crude protein content was determined using a protein content analyzer (KjelFlex 360, Buchi, Switzerland) and assessed by the gravimetric method. Fat content was determined using a fat extractor (Tecator 1043 Extractor Unit, Soxtec System HT, Sweden). The crude ash content was determined by heating samples at $550 \pm 10^\circ\text{C}$ for 24 h in a furnace (Wise Therm, Witeg, Germany).

Water soluble protein

Water soluble protein content dissolved in the broth of *Samgyetang* was determined by analyzing the supernatant using the Bradford method (Bradford, 1976). Briefly, broth samples (100 μL) were mixed with Coomassie Blue (5 mL) as a standard solution by using a vortex mixer (KMC-1300 V, Vision Scientific Co., Ltd., Korea) for 30 s. The mixture samples were then incubated for 10 min and measured at 595 nm absorbance. Each treatment was performed in triplicate. The average of the absorbance value was then calculated. Standard solutions used in all of the calibration curves were obtained after correct dilution of bovine serum albumin (BSA) (Sigma-Aldrich Co., USA) protein standard (1 mg/mL). Water soluble protein determination was carried by using the BSA standard calibration curve, and expressed as a percentage of the total soluble proteins in the sample (w/w, dry basis).

Apparent viscosity

Apparent viscosity was measured on the broth of *Samgyetang* which was sieved by using a 350- μm sieve according to the method of Moyunga *et al.* (2014) with some modifications. The filtrate (400 mL) was poured into a 500-mL beaker glass without applying any compulsory physical force for 30 min at 25°C. Apparent viscosity was measured using a viscometer (DV-II, Brookfield Eng., USA) equipped with cylindrical RV spindle No. 1 at 20 rpm. The apparent viscosity value was expressed as centipoises (cp).

Quantitative descriptive analysis (QDA)

The sensory evaluation of *Samgyetang* was performed by using QDA method (Stone and Sidel, 1985). Prior to the sensory evaluation, the panelists were given an information pack incorporating a questionnaire. The panel consisted of 11 semi-trained faculty members and students

aged between 22 and 61 years (mean = 27.3 years, SD = 11.3). They evaluated quality change characteristics including overcooked chicken flavor, bloody and metallic chicken smell, browning color of meat and broth, fatty droplets on broth, softness of porridge, and plain taste. Each of the RTE *Samgyetang* was divided into three parts: whole chicken meat, broth, and porridge on separate plates. The samples in this study were identified with three-digit random numbers, and presented to the panelists under three wavelength lamps (1,200 lux). The packaged samples were first warmed up at 85°C in hot water for 15 min. The panelists evaluated the samples according to the following scales; 9 = extremely like, 7 = like, 5 = moderately like, 3 = dislike, and 1 = extremely dislike.

Statistical analysis

All data were analyzed by one-way analysis of variance using the SPSS (ver. 14.0) statistical package. The analyses were performed in three repetitions for each sample. The means of data in the pre-cooking conditions were compared using Duncan's multiple range tests to determine the significance at $p < 0.05$.

Results and Discussion

Proximate composition

Table 1 shows the proximate composition of RTE *Samgyetang* treated under various pre-cooking temperature and time conditions. Significant differences between the control and the treatment samples were observed in moisture and crude fat content ($p < 0.05$). The moisture contents of

the control were 70.27% in breast meat and 71.64% in leg meat, but those of T1, T2, T3, and T4 were each reduced by 0.46 to 0.70% and 0.34 to 0.36% in breast and leg meats, respectively. The lower moisture content of the meat samples under pre-cooking treatments might be related to the denaturation process of myofibrillar protein as a result of heat treatment which can adversely affect the water-holding capacity.

The crude fat contents of *Samgyetang* investigated in this experiment in the control were 1.88% and 2.10% for breast and leg meats, respectively. These values were higher than the results recorded by Wattanachant *et al.* (2004) who reported 0.68% and 0.81% for breast and leg meats, respectively. However, the fat contents in the breast meat were still in the range of indigenous chicken fat content reported by Wattanachant *et al.* (2008) which was measured at between 0.20% and 2.88%. This can be attributed to the different product type and preparation method of the products. Pre-cooking treatments significantly reduced the fat contents in breast and leg meats by 8.5 to 11.7% and 10.0 to 11.0%, respectively ($p < 0.05$). Nevertheless, among the different pre-cooking temperature and time conditions, no significant effects on the fat contents of breast and leg meats were observed ($p > 0.05$). Besides, the crude fat content of the broth tended to be slightly reduced by pre-cooking treatments at 1.19% (T1), 1.15% (T2), 1.12% (T3) and 1.17% (T4), even though no statistical significance was recognized ($p < 0.05$). These results showed the positive effect of pre-cooking, by reducing the crude fat content, and therefore potentially making the product more acceptable to consumers.

Table 1. Proximate composition of RTE *Samgyetang* depending on pre-cooking conditions

| Proximate composition | Samples | Pre-cooking conditions ¹⁾ | | | | |
|-----------------------|---------------------------|--------------------------------------|-------------------------|-------------------------|-------------------------|-------------------------|
| | | C (Not pre-cooked) | T1 (50°C/30 min) | T2 (65°C/30 min) | T3 (85°C/30 min) | T4 (90°C/10 min) |
| Moisture (%) | Breast meat | 70.27±0.37 ^a | 69.95±0.35 ^b | 69.83±0.30 ^b | 69.94±0.30 ^b | 69.78±0.33 ^b |
| | Leg meat | 71.64±0.33 ^a | 71.38±0.30 ^b | 71.40±0.30 ^b | 71.40±0.30 ^b | 71.38±0.32 ^b |
| | Broth ^{NS} | 96.20±0.12 | 96.20±0.10 | 96.20±0.10 | 96.10±0.17 | 96.00±0.19 |
| Crude protein (%) | Breast meat ^{NS} | 27.35±0.11 | 27.85±0.11 | 28.00±0.11 | 27.90±0.14 | 28.00±0.12 |
| | Leg meat ^{NS} | 25.79±0.11 | 26.26±0.15 | 26.25±0.11 | 26.26±0.14 | 26.26±0.12 |
| | Broth ^{NS} | 1.88±0.18 | 1.81±0.14 | 1.85±0.13 | 1.88±0.14 | 1.83±0.11 |
| Crude fat (%) | Breast meat | 1.88±0.15 ^a | 1.70±0.13 ^b | 1.67±0.12 ^b | 1.66±0.14 ^b | 1.72±0.14 ^b |
| | Leg meat | 2.10±0.11 ^a | 1.89±0.15 ^b | 1.88±0.11 ^b | 1.87±0.14 ^b | 1.89±0.12 ^b |
| | Broth ^{NS} | 1.22±0.18 | 1.19±0.14 | 1.15±0.13 | 1.12±0.14 | 1.17±0.17 |
| Crude ash (%) | Breast meat ^{NS} | 0.50±0.05 | 0.50±0.07 | 0.50±0.09 | 0.50±0.04 | 0.50±0.02 |
| | Leg meat ^{NS} | 0.50±0.07 | 0.50±0.07 | 0.50±0.04 | 0.50±0.04 | 0.50±0.09 |
| | Broth ^{NS} | 0.70±0.08 | 0.80±0.07 | 0.80±0.09 | 0.90±0.14 | 1.00±0.12 |

¹⁾Results are expressed as mean±SE.

^{a,b}Values within each row with different superscripts are significantly different ($p < 0.05$).

^{NS}Not significantly different ($p > 0.05$).

Awonorin *et al.* (1995) indicated that thermal processing with higher temperature and longer time conditions could affect the proximate composition of poultry by-product meals. It was also reported that increasing pre-cooking temperature could reduce water-holding capacity (Larick and Turner, 1992), thus the levels of moisture content (Awonorin *et al.*, 1995).

pH value

The results of pH as presented in Table 2 indicated that pre-cooking conditions at a higher temperature and for a longer time showed more vulnerability to pH changes. The pH values of the control samples of breast meat, leg meat, and broth were 7.37, 7.33, and 6.90, respectively. On the other hand those of the pre-cooked samples tended to decrease, and were observed at 6.80 to 7.37% for breast meat, 6.67 to 7.33% for leg meat, and 6.60 to 6.90% for broth. pH values tended to decrease with higher pre-cooking temperature and longer time, especially for T3 which showed the lowest pH values on breast and leg meats, and broth samples. The pH values of breast and leg meats in T3 and T4 were significantly different from those of the control, T1 and T2 ($p < 0.05$), while those of T1 and T2 were not significantly different from the control ($p > 0.05$). The decrease in the pH values of pre-cooked *Samgyetang* might be related to non-enzymatic Maillard reactions of amino acids and glucose contained in the meat. Maillard reaction itself is a reaction involving amino acids and reduced sugar that occurs in thermally processed food. Our result is supported by the previous experiment by Liu *et al.* (2008) who explained that acids formed as a conse-

quence of amino group consumption by Maillard reaction, and reduced pH value by a logarithm-ordered kinetics mechanism, as a function of galactose concentration.

Instrumental color

Changes in instrumental color on the breast meat, leg meat, and broth of *Samgyetang* depending on pre-cooking conditions are presented in Table 2. The L* and b* values of breast and leg meats treated under higher temperature and longer time conditions were significantly higher than the control ($p < 0.05$), while a* values tended to decrease, although not to a significant extent ($p > 0.05$). These results were similar to those of Wattanachant *et al.* (2005), who reported that temperature increments can cause a lightening of the meat's color and a brown-grey hue in Thai indigenous and broiler chicken. They observed that the L* and b* values of chickens went up significantly with increasing temperature between 50 and 70°C, while a* value of chicken decreased with heat treatment. The lightening mechanism in color measurement is due to an increased reflection of light scattering on the denatured protein in the muscle (Young and West, 2001), while the transformation in hue and the loss of chroma is induced by myoglobin changes (Lawrie, 1994). Lower a* values of breast and leg meats in the T3 and T4 samples compared to other samples might be related to the denaturation process of myoglobin. According to Lawrie (1994), myoglobin is a heat-stable sarcoplasmic protein, which is almost completely denatured after heating at more than 80°C.

The L*, a*, and b* values of broth were not significantly different among treatments ($p > 0.05$) except for T3

Table 2. pH value and instrumental color of RTE *Samgyetang* depending on pre-cooking conditions

| Variables | Samples | Pre-cooking conditions ¹⁾ | | | | |
|-----------|---------------------------|--------------------------------------|--------------------------|--------------------------|-------------------------|--------------------------|
| | | C (Not pre-cooked) | T1 (50°C/30 min) | T2 (65°C/30 min) | T3 (85°C/30 min) | T4 (90°C/10 min) |
| pH | Breast meat | 7.37±0.00 ^a | 7.33±0.01 ^{ab} | 7.28±0.01 ^{ab} | 6.80±0.00 ^c | 7.15±0.01 ^b |
| | Leg meat | 7.33±0.02 ^a | 7.20±0.02 ^{ab} | 7.13±0.01 ^{ab} | 6.67±0.01 ^c | 6.98±0.02 ^b |
| | Broth | 6.90±0.02 ^a | 6.90±0.01 ^a | 6.80±0.01 ^b | 6.60±0.02 ^c | 6.80±0.02 ^b |
| CIE L* | Breast meat | 80.74±0.01 ^c | 82.67±0.03 ^b | 82.94±0.10 ^b | 82.96±0.14 ^b | 83.54±0.10 ^a |
| | Leg meat | 68.72±0.01 ^c | 69.69±0.03 ^b | 70.97±0.10 ^a | 69.21±0.14 ^b | 71.09±0.10 ^a |
| | Broth | 90.69±0.21 ^a | 91.46±0.25 ^a | 91.43±0.12 ^a | 89.60±0.37 ^b | 90.88±0.20 ^a |
| a* | Breast meat ^{NS} | 5.23±0.08 | 5.21±0.03 | 5.20±0.03 | 4.99±0.03 | 5.14±0.05 |
| | Leg meat ^{NS} | 5.67±0.04 | 5.60±0.04 | 5.55±0.05 | 5.45±0.06 | 5.52±0.03 |
| | Broth | -0.61±0.01 ^{bc} | -0.70±0.01 ^c | -0.71±0.01 ^c | -0.50±0.02 ^a | -0.60±0.02 ^{bc} |
| b* | Breast meat | 14.77±0.05 ^c | 14.81±0.05 ^{bc} | 15.15±0.04 ^{bc} | 18.91±0.05 ^a | 16.88±0.08 ^b |
| | Leg meat | 11.16±0.06 ^c | 12.62±0.05 ^d | 13.94±0.05 ^c | 17.10±0.02 ^a | 15.14±0.05 ^b |
| | Broth | 15.87±0.24 ^b | 15.28±0.10 ^b | 15.26±0.01 ^b | 18.89±0.02 ^a | 15.21±0.13 ^b |

¹⁾Results are expressed as mean±SE.

^{a-e}Values within each row with different superscripts are significantly different ($p < 0.05$).

^{NS}Not significantly different ($p > 0.05$).

which showed the lowest L^* and the highest a^* and b^* values ($p < 0.05$). This could result from Maillard reaction because of pre-cooking at a higher temperature and for a longer time than the other treatments. Nathakaranakule *et al.* (2007) reported that a color change to brown was observed in dried chicken as a result of the reaction of amino group proteins with available reducing sugars contained in the connective tissue of the chicken. The Maillard reaction between the sugar and the amino group is promoted by increasing temperature and time during the heating process (Martin and Mela, 1994). The Maillard reaction which occurred on T3 might affect other parameters such as transmittance and QDA.

Cooking loss

Cooking loss in the chicken meat with varying pre-cooking conditions is presented in Table 3. Piette *et al.* (2001) showed the possibility of extracting rendered chicken fat at lower temperatures ranging from 50°C to 80°C. In our study, the higher temperature and longer time conditions of pre-cooking treatments resulted in more cooking loss on the whole chicken meat samples of *Samgyetang*. Pre-cooking treatment of T1 with the lowest temperature condition showed the lowest cooking loss (1.74%), followed by T2 (3.02%), T4 (3.25%), and T3 (6.97%). Our results indicated that increasing temperature and time conditions for pre-cooking significantly increased cooking loss. It should be noted that the T3 pre-cooking treatment, which applies the highest temperature and longest time conditions, and which is also the most common practice conducted in the *Samgyetang* industries in Korea, has the highest percentage of cooking loss. This observation was consistent with a previous result of Wattanachant *et al.* (2005) who reported that the cooking loss in broiler chicken increased with increments of heating temperature from 50°C to 100°C, especially in the range of 80°C to 100°C. The fact that the values of cooking loss were increased with the elevation of pre-cooking temperature implied that the cooking loss in temperatures from 50°C to 85°C was influenced by reduced water-holding capacity at the higher temperature.

Duration of pre-cooking process also had significant effect on cooking loss. Pre-cooking in T4 resulted in lower cooking loss than in T3 (Table 3). A shorter exposure to high temperature resulted in a slower denaturation process. This result is supported by the observation of Tornberg (2005) who stated that high cooking loss, caused by changes in water-holding capacity, was related to the extent of heat denaturation of myofibrillar proteins.

Texture profile

Texture profile of *Samgyetang* breast meat samples showed insignificant differences in hardness, cohesiveness, and springiness ($p > 0.05$). Gumminess values in T1 and T3 and brittleness values in the T1, T2, T3, and T4 samples did, but show significant variation from the control (Table 3) ($p < 0.05$). Actually, the impact of heat exposure during the retorting process of *Samgyetang* is far greater than that experienced during the pre-cooking process. The result was proven by the insignificant differences in the values of hardness, cohesiveness, and springiness of treated samples after the retorting process compared to the control ($p > 0.05$). This is in agreement with the work of Voller-Reasonover *et al.* (1997) who explained that high-temperature processing can be detrimental to the textural quality of fowl meat. Palka (1999) also explained that the effect of cooking meat on bovine muscle involves a structural change in the intramuscular connective tissue and its mechanical properties because of collagen denaturation.

Apparent viscosity and water soluble protein

The results regarding apparent viscosity and water soluble protein were not significantly different between the control and the pre-cooking treatments as shown in Table 3 ($p > 0.05$). From this observation, it can be assumed that the retorting process at high temperature and pressure under the F-value 8.0 must have more negative influences on the quality parameters including apparent viscosity and water soluble protein than the pre-cooking treatment itself. Ishiwatari *et al.* (2013) reported that myosin and actin in meat denature at between 40°C and 80°C. This temperature range is far lower than that of the retorting process at 120°C as a result of which less denaturation on the myosin and actin, the major components of myofibrillar protein, might occur.

Transmittance

The percentage transmittance values of broth of pre-cooked samples were significantly higher than the control, except for T3 (Table 3). T3, with the second highest temperature and longest time conditions among the treatments, had the lowest percentage of transmittance, which could be due to Maillard reaction. Ames (1998) explained that the different heating conditions used and the types of reactants are two factors which can generate Maillard reaction. The brown color on the T3 broth as a result of Maillard reaction might have induced the lower panel acceptance values on the QDA, compared to other treatments.

Table 3. Cooking loss, texture profile, water soluble protein, apparent viscosity, transmittance, and average values of QDA from RTE *Samgyetang* depending on pre-cooking conditions

| Variables | Pre-cooking conditions ¹⁾ | | | | |
|---|--------------------------------------|-------------------------|-------------------------|------------------------|-------------------------|
| | C (Not pre-cooked) | T1 (50°C/30 min) | T2 (65°C/30 min) | T3 (85°C/30 min) | T4 (90°C/10 min) |
| Cooking loss (%) | | 1.74±0.03 ^c | 3.02±0.03 ^b | 6.97±0.02 ^a | 3.25±0.02 ^b |
| Texture profile | | | | | |
| Hardness (kg/m ²) ^{NS} | 1.64±0.25 | 1.66±0.25 | 1.69±0.16 | 1.65±0.07 | 1.64±0.06 |
| Cohesiveness (%) ^{NS} | 0.22±0.20 | 0.20±0.21 | 0.21±0.26 | 0.21±0.25 | 0.18±0.25 |
| Springiness (%) ^{NS} | 90.30±0.61 | 91.01±0.36 | 89.06±0.40 | 91.54±0.31 | 89.09±0.45 |
| Gumminess (kg) | 3.85±0.01 ^a | 3.39±0.01 ^{bc} | 3.45±0.01 ^{ab} | 3.12±0.02 ^c | 3.79±0.00 ^{ab} |
| Brittleness (kg) | 3.89±0.01 ^a | 3.14±0.01 ^d | 3.28±0.01 ^c | 3.72±0.00 ^b | 3.02±0.01 ^e |
| Apparent viscosity (cp) ^{NS} | 8.50±0.50 | 8.50±0.50 | 8.58±0.51 | 8.47±0.52 | 8.49±0.51 |
| Water soluble protein (%) ^{NS} | 1.64±0.04 | 1.65±0.06 | 1.63±0.13 | 1.64±0.03 | 1.69±0.01 |
| Transmittance (%) | 0.12±0.00 ^d | 0.13±0.00 ^c | 0.16±0.00 ^a | 0.11±0.00 ^e | 0.15±0.00 ^b |
| Average values of QDA | 6.95±0.10 ^c | 7.12±0.31 ^b | 7.30±0.12 ^a | 6.65±0.21 ^d | 7.12±0.012 ^b |

¹⁾Results are expressed as mean±SE.

^{a-e}Values within each row with different superscripts are significantly different ($p < 0.05$).

^{NS}Not significantly different ($p > 0.05$).

QDA

As shown in Table 3, sensory evaluation from the average values of QDA showed that T3 had the lowest preference compared to the other treatments. The results of QDA in Fig. 1 show that the browning of the broth reduced acceptability in T3 compared to the other samples. This might be related to the Maillard reaction which occurred in the meat and broth of *Samgyetang*, while T2 with a more mild temperature condition had better scores (wider

QDA graph) with regard to the quality of *Samgyetang* compared to other pre-cooking treatments. The lowest sensory score was observed in T3 samples, probably caused by the increased brownness of both meat and broth and their overcooked chicken flavor. These results indicated that browning color related to Maillard reaction might lead to a lower level of preference by panelists for the T3 samples than for the control and other pre-cooking treatments.

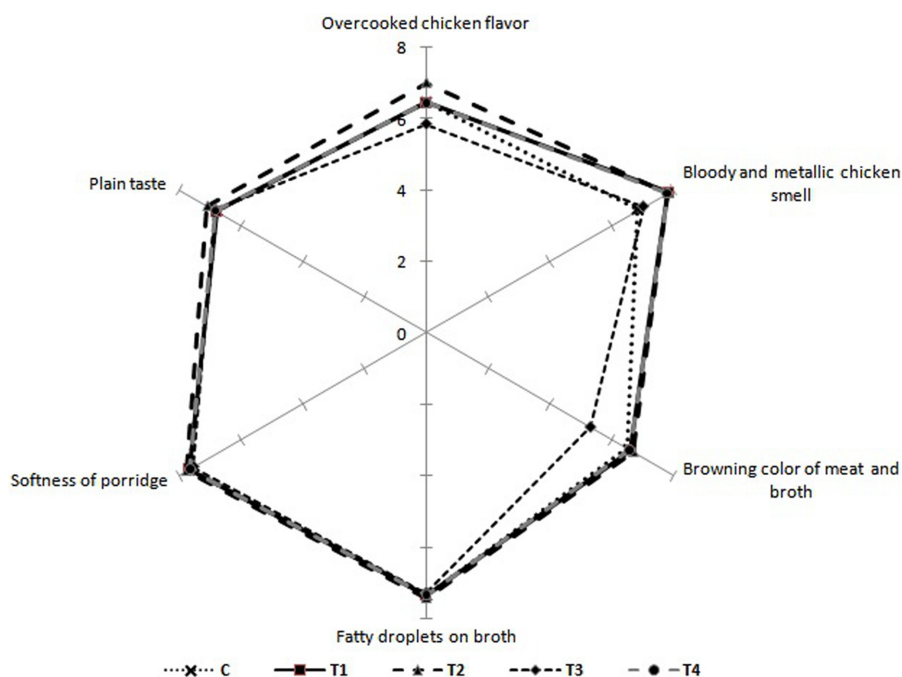


Fig. 1. Quantitative descriptive analysis of *Samgyetang* depending on pre-cooking conditions. Scores are assessed using 9-point hedonic scale (9=extremely like, 7=like, 5=moderately like, 3=dislike, and 1=extremely dislike). For details of pre-cooking conditions, please refer to Table 1.

Conclusions

In the manufacture of *Samgyetang*, pre-cooking treatment is a plausible way to reduce its fat content, and thereby improve its appeal and marketability. In terms of specific conditions, pre-cooking at 65°C for 30 min, or alternatively at the higher temperature and shorter time of 90°C for 10 min are recommended to achieve a lower fat content in the meat, clearer broth, and superior sensory scores, as compared to the other samples. The current, common industry standard pre-cooking conditions of 85°C for 30 min, were shown to produce the worst quality among the samples tested. This finding should be useful in the commercial production of retorted *Samgyetang* and other relevant meat products, giving better quality outcomes than current, conventional processing methods in the industry.

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