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The Quality Characteristics of Ready-to-Eat Empal Gentong affected by meat pre-cooking

Abstract

The purpose of this research was to examine the effectiveness of pre-cooking treatments on the quality characteristics of ready-to-eat (RTE) empal gentong. Raw beef meat was precooked in water bath at 90℃ for 0 min (C), 10 min (T1), 20 min (T2), and 30 min (T3) prior to retorting process at 121℃ and pressure at 0,7 bars. Results showed that pre-cooking treatments in all treated samples could reduce fat contents in empal gentong's meat by 0.02% (T1), 0.28% (T2), and 1.13% (T3) respectively. Highest precooking time tends to increase the pH and CIE a* values. However, CIE b* values, water holding capacity (WHC), and sensory analysis were not affected by pre-cooking duration which must have been affected by sterilization process after precooking. In conclusion, pre-cooking treatment before sterilization in producing empal gentong is a probable technique to reduce its fat content and improve its physical quality. A specific treatment at 90℃ for 10 min is recommended to achieve optimum quality of ready-to-eat empal gentong's meat.

Keywords: pre-cooking, meat, ready-to-eat, empal gentong, quality characteristic

Introduction

Interest in traditional food products has grown in both developed and developing countries (Anders and Caswell 2009). As a country with diverse cultures and traditions, Indonesia has a variety of traditional foods (Rianti et al. 2018). Empal gentong, a traditional food originating in Cirebon, Indonesia, is meat prepared with mixed spices and coconut milk. However, consumers nowadays complain about fat droplets in the broth and the short shelf life of the product. Therefore, retort packaging, which involves sterilization at high temperatures, is used to produce ready-to-eat (RTE) empal gentong.

The quality of RTE empal gentong meat was the focus of this study. Some small and medium level industries still use the conventional method of pre-cooking without a standard. However, several recent studies have aimed to reduce the fat content and improve the visual appeal of meat products. Triyannanto and Lee (2015) showed that pre-cooking successfully improves the quality of Korean ginseng chicken soup, as judged by consumer acceptance. Furthermore, Manheem et al. (2013) reported that a cheap and simple pre-cooking process is important for extending the shelf life of food products. Accordingly, our study aimed to identify the optimal pre-cooking method for RTE empal gentong by evaluating the quality characteristics of the meat prepared using various pre-cooking treatments.

Materials and Methods

Meat preparation and precooking treatment

Fresh beef meat was purchased from the local butcher's market in Yogyakarta City of Indonesia, and immediately brought to the laboratory. The fresh beef meat (*longissimus dorsi*) was cut into cubes with a size of 3x3x3 cm (LxWxH) to be prepared for pre-cooking treatment. The meat samples were then packed with sealable PE plastics bag. The precooking process was carried out by heating the meat samples in the water bath at a temperature of 90℃. There were four group treatment of pre-cooking time namely control/without pre-cooking (C), 10 min (T1), 20 min (T2) and 30 min (T3) of pre-cooking time with five replications. The curry was separately prepared by mixing the coconut milk, spices, and hot water. The curry was heated at a temperature of 80-90℃ for 45 min.

RTE Empal gentong preparation

A total of 50 g meat cubes was introduced to multilayer retort pouch with a specific layer arrangement of PET / ALU / ONU / CPP, 16.0 cm x 22.9 cm (WxH) size. About 300 ml of hot curry was poured into the pouch, then was sealed by using a continuous sealer machine. Afterward, the sterilization process was carried out using a retort machine which was operated by holding a pressure of 10.15 psi, 9 min until sterility value is obtained. After sterilization, a cooling process was carried out in room temperature water at 22-25℃ for 10 min. The RTE empal gentong samples were then analyzed.

pH value

Ten grams of empal gentong’s meat was chopped and then transferred into 40 mL of distilled water, homogenized at 10.000 rpm for 60 s using a homogenizer. The pH values were measured using a pH meter attached with an electrode (Orion Star A111 Benchtop, Thermo Fisher Scientific Inc, Singapore). The pH value was performed in triplicate per treatment (Muhlisin et al. 2013).

Tenderness

Samples of empal gentong’s meat with a thickness of 0.5 cm and 1.5 cm width were placed on the Warner-Bratzel instrument (Soeparno 2015)

Water holding capacity

The analysis of the water holding capacity (WHC) in this research using the method of (Hamm 1972). Samples in amount of 0.3 gr placed on filter paper and pressed between 2 glass plates, and then given 35 kg load for 5 min. The area which absorbed water was then counted with planimeter. WHC then calculated with the following formula:

$$mgH_2O = \frac{wet\ area\ (cm2)}{0,0948} - 8$$

$$\% \text{ free water} = \frac{mgH2O}{weightsample(mg)} \times 100\%$$

The sample used for water content assay was 1 g. Weighed samples then inserted into filter paper and oven dried at 105℃ for 24 h (Soeparno 2015).

$$\text{WHC} = \frac{x + y - z}{x} \times 100\%$$

$$\%\text{WHC} = \text{TWC} - \% \text{ free water}$$

Where X = Sample weight; Y = filter paper weight; Z = Sample weight + filter paper weight after being oven; and TWC = Total Water Content.

Cooking loss

The analysis of the cooking loss in this research using the method of Bouton et al., (1972). The meat was cut in the direction of the fiber and weighed as much as 25 g. Afterwards, the meat was put in polyethylene plastic and packed with a vacuum machine. The meat was cooked in a water bath at 90℃ for 0 min (C), 10 min (T1), 20 min (T2), and 30 min (T3) min. The meat was then cooled and removed from the polyethylene plastic and then wiped with a tissue and the final weight is weighed.

$$\text{Cooking Loss} = \frac{x - y}{x} \times 100\%$$

Where x = initial weight; y = final weight

Proximate analysis

Chemical analysis method for this research were water, fat, protein, and collagen content by using a food scanner (FoodScan ™ Meat Analyser; FOSS, Padova, Italy) with NIRS (Near Infrared Reflectance Spectroscopy) technology. Thirty grams of sample were grinded and checked in food scanner with a special petri dish. Samples checked in triplication (Triyannanto et al. 2019)

Sensory analysis

Sensory analysis following the method described by Triyannanto and Lee, (2015). The total of 11 male and female semi-trained panellists aged 17- 21 years conducted a sensory analysis for RTE empal gentong. Sensory procedures were explained in detail to the panellists before conducting a sensory test. A pack questionnaire was given to be filled during a sensory analysis. Every sample was labelled with 3 different numbers to decline the subjective score possibility. To support the sensory analysis lamp room with a 1,200-lux brightness were applied. Panellists are required to rinse their mouth after the analysis for each different sample. These procedures were designed to avoid cross-contamination of the sensory characteristics in each sample. Furthermore, the panellist was obliged to fill the questionnaire that has been provided. Sensory analysis in this research was contained of four parameters namely, color, tenderness, taste, texture, and flavour. Parameter scales were set at; 5: very like, 4: Like, 3: plain 2: dislike, and 1: very dislikes.

Statistical analysis

SPSS Statistics (version 25.0; (IBM, 2017) for Windows Evaluation Version was used to analyze all data. The data were analyzed using one way analysis of variance and Duncan's multiple range test for significant differences ($p<0.05$).

Results and Discussion

pH value

Table 1 shows that pre-cooking time significantly affected the pH value of the meat ($p < 0.05$). The pH value was 6.31 in the control and tended to increase with longer pre-cooking times. The pH values in this study might have been affected by the heating process, which causes amino acids to lose their carboxyl groups. A decrease in the number of acidic groups was also observed by Hamm and Deatherage (1960), who showed that ground longissimus dorsi muscle lost almost one-third of its carboxyl groups when heated at 20-70℃ for 30 min in a water bath contained by a covered metal vessel.

Water-holding capacity

Table 1 shows that the pre-cooking time did not significantly affect the water-holding capacity of the meat ($p > 0.05$). The water-holding capacity was dependent on the amount of denaturation of the meat protein. The absence of a significant effect was possibly caused by the complete denaturation of protein during the sterilization process at 121℃, which resulted in a constant water-holding capacity among all treatments. High pressure thermal processing after pre-cooking results in complete protein denaturation. In accordance with this, Sun et al. (2016) reported that in beef, pork, and chicken, commercial sterilization at 121℃ for 10 min leads to protein-bound water but does not significantly affect the protein and fat content in beef and pork. Moreover, Soeparno (2015) showed that myofibril protein coagulates at 30℃ and completely denatures at 55℃, which is lower than the commercial sterilization temperature. Furthermore, Gómez et al. (2020) reported that high pressure and temperature do not significantly affect the cooking loss rate or water-holding capacity.

Tenderness

The tenderness of the meat was measured by determining the content of connective tissue, such as collagen. As shown in Table 2, decreased penetrometer values indicated that tenderness increased significantly ($p < 0.05$). Pre-cooking produced penetrometer values of 4.26 kg/cm^2 (T1), 4.23 kg/cm^2 (T2), and 4.13 kg/cm^2 (T3), which were lower than those of the control (6.40 kg/cm^2). A lower penetrometer value objectively shows that less energy and pressure are required for chewing. Collagen hydrolysis during pre-cooking resulted in increased tenderness. Lawrie and Ledward (2006) reported that cooking affects meat structure, softening the connective tissue by converting collagen into gelatin. Moreover, Soeparno (2015) stated that tenderness reflects the amount of collagen present and that long boiling times cause changes in the structure of muscle proteins, especially actin and myosin. The breakdown of actin and myosin can influence the mechanical strength of connective tissue (Bouton and Harris, 1972).

Cooking loss

The cooking loss observed in each pre-cooking condition is presented in Table 2. An extrinsic factor that affected cooking loss was pre-cooking duration. Meat subjected to longer pre-cooking treatments tended to exhibit significantly greater cooking losses than those subjected to shorter treatments. Meat in the T3 group, pre-cooked for 30 min, exhibited the greatest cooking loss. This loss might consist of water and other water-soluble components, such as proteins. High pre-cooking temperatures up to 90℃ decreased the initial weight of the empal gentong meat by almost half. This result was in accordance with that found by Tornberg (2005), who stated that the greatest cooking loss in beef occurs at 60-80℃, which is lower than the pre-cooking temperature used in our study. Hearne et al. (1978) also reported that higher endpoint temperatures result in greater cooking loss in bovine semitendinosus meat.

Instrumental color

The instrumental color values, CIE L* (lightness), a* (redness), and b* (yellowness), are presented in Table 1. The CIE L* and a* values of RTE empal gentong meat in the T2 group were lower than those in the T1 group, indicating that these values tended to decline with longer pre-cooking times ($p > 0.05$). However, the highest values were observed in meat pre-cooked for 30 min (T3) ($p < 0.05$). As reported by Muhlisin et al. (2013), chuncheon dalkalbi meat with a lower CIE L* value exhibits a darker color. The effect of pre-cooking time on the CIE L* and a* values of empal gentong meat in this study was not clear. Certain ingredients of RTE empal gentong, such as turmeric, ginger, and other herbs, which naturally tend to be yellow in color, might have been responsible for the CIE L* and a* values during processing. Longer pre-cooking time had no effect on the CIE a* value ($p > 0.05$). It seemed that sterilization at 121 ℃ was responsible for more defects than the pre-cooking duration, which produced a non-significant CIE b* value. Myoglobin, responsible for the red color of meat, turns grayish brown at 75℃ (Hunt et al., 1999), which is lower than the pre-cooking temperature of 90℃ and far lower than the sterilization temperature of 121℃ used in this study. Moriyama and Takeda (2010) reported that myoglobin is mostly destroyed at 70-100℃.

Proximate composition

Table 2 shows the proximate composition of RTE empal gentong subjected to the various pre-cooking times. Significant differences in moisture, protein, fat, and collagen were observed between the control and experimental groups ($p < 0.05$). As shown in Table 2, the moisture content of the control was 67.16 % (w/w), but that of the T1, T2, and T3 groups was reduced by 1.54-5.92%. The lower moisture content of the meat samples subjected to pre-cooking treatments might be related to the heat-induced denaturation of myofibrillar protein, which can adversely affect the water-holding capacity (Triyannanto and Lee 2015). This result is in accordance with the results shown in Table 1, which indicated greater cooking loss with longer pre-cooking duration.

The crude protein content of the control was 23.93%, while that of the T1, T2, and T3 groups was reduced by 0.18-0.84%. Cooking at a high temperature for a long time causes the protein content to decrease. Tornberg (2005) reported that the heating process results in denaturation of myofibril proteins and changes in protein structure. In addition, the soluble protein content decreases by approximately 90% as the meat temperature increases from 23℃ to 80℃ (Murphy and Berrang, 2002). In accordance with this, the decrease in protein content observed in our study paralleled the decrease in collagen composition.

The crude fat content of the empal gentong control samples was 6.26%. Pre-cooking significantly reduced this value by 0.02% (T1), 0.28% (T2), and 1.13% (T3). In this study, pre-cooking prior to sterilization was a suitable way to reduce the fat content ($p < 0.05$). However, the longer duration of pre-cooking required to achieve the decrease in fat content might also decrease meat quality, manifested as a higher percentage of cooking loss. Therefore, pre-cooking for 10 min could be a solution for producing RTE empal gentong with a lower fat content as well as a higher proximate content. The RTE empal gentong in the T1 group had better quality than that in the other pre-cooking treatment groups, although there were no significant differences between the T1 group and the control ($p > 0.05$). This result is in accordance with a prior study conducted by Triyannanto and Lee (2015), who showed that precooking at 90℃ for 10 min is an effective way to improve the quality of Korean ginseng chicken soup.

Collagen content did not differ significantly between the control (2.53%) and T1 groups (2.43%), while that of the T2 and T3 groups was significantly reduced by 0.10-0.47%. There was no significant difference in collagen content between the T2 and T3 groups ($p > 0.05$). The results showed that denaturation induced by pre-cooking tended to reduce collagen levels. Tornberg (2005) reported that collagen denaturation occurred at 53-63℃ and that gelatin was formed with further heating. Some of the gelatin observed in this research might dissolve in the empal gentong broth during the sterilization process.

As shown in Table 3, sensorial values in all treatment groups were not affected by pre-cooking conditions ($p > 0.05$). The sterilization process, with a temperature of 121℃ and pressure of 10.15 psi, probably had a greater effect than pre-cooking on sensorial values. From this study, it could be concluded that sterilization at a high temperature and pressure has a greater influence on all sensory qualities of empal gentong meat than the duration of pre-cooking. As reported by Triyannanto and Lee (2015), heat exposure during sterilization at 120℃ for 65 min had a greater impact than pre-cooking on ginseng chicken soup products. However, although sterilization has a significant effect on sensory qualities, it is necessary for producing RTE empal gentong that is free of spoilage-inducing microbes and pathogens.

Conclusion

The current conventional empal gentong production without pre-cooking produce high fat content, which tend to be unpleasant to consumer’s perspective. Pre-cooking treatment can be used in manufacturing RTE empal gentong to optimize its quality. Specific pre-cooking condition at 90℃ for 10 min is recommended to maintain its proximate with a lower fat content. This finding should be useful in the commercial production of RTE empal gentong or other relevant products, giving an optional outcome with low fat but high proximate content product as well as economically visible.

Conflicts of interest

The authors declare no potential conflict of interest

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Tables

Table 1. pH value, Tenderness, WHC, Cooking Loss and Instrumental Color of Meat RTE Empal Gentong Depending on Pre-cooking Conditions

Physical Parameters	Pre-cooking conditions			
	C (Not pre-cooked)	T1 (90℃/10 min)	T2 (90℃/20 min)	T3 (90℃/30 min)
pH value	6.31±0.01^{b}	6.33±0.06^{b}	6.34±0.01^{b}	6.41±0.02^{a}
Tenderness (kg/cm^2)	6.40±0.20^{a}	4.26±0.25^{b}	4.23±0.25^{b}	4.13±0.15^{b}
WHC^{NS}	43.00±3.60	42.33±3.21	36.33±0.57	34.00±7.00
Cooking loss	-	39.00±1.73^{b}	41.67±1.15^{b}	46.67±2.30^{a}
CIE L*	15.53±0.25^{b}	14.30±0.95^{c}	13.66±0.15^{c}	20.20±0.00^{a}
a*	4.66±0.05^{ab}	4.43±0.25^{b}	3.90±0.88^{b}	5.43±0.11^{a}
b*^{NS}	14.53±0.05	11.03±2.37	12.40±2.07	14.86±0.26

Results are expressed as mean±SD.

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

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

Table 2. Proximate Composition of RTE Empal Gentong's Meat Depending on Pre-cooking Conditions

Proximate Composition (%)	Pre-cooking conditions			
	C (Not pre-cooked)	T1 (90℃/10 min)	T2 (90℃/20 min)	T3 (90℃/30 min)
Moisture	67.16±0.10[a]	65.62±0.38[b]	65.49±0.04[b]	61.24±0.21[c]
Protein	23.98±0.14[a]	23.80±0.27[a]	23.57±0.50 [ab]	23.14±0.09[b]
Fat	6.26±0.10[a]	6.24±0.06[a]	5.98±0.03[b]	5.13±0.10[c]
Collagen	2.53±0.29[a]	2.43±0.08[a]	2.25±0.17[b]	2.06±0.06[b]

Results are expressed as mean±SD.

[a,b,c]Values within each row with different superscripts are significantly different ($p<0.05$).

[NS] Not significantly different ($p>0.05$)

Table 3. Sensory Characteristics of Meat RTE Empal Gentong Depending on Pre-cooking Conditions

Sensory analysis	Pre-cooking conditions			
	C (Not pre-cooked)	T1 (90℃/10 min)	T2 (90℃/20 min)	T3 (90℃/30 min)
Color [NS]	3.92±0.49	4.00±0.40	3.96±0.53	3.96±0.53
Texture [NS]	3.48±0.82	3.64±0.86	3.76±0.96	3.96±0.78
Flavor [NS]	3.72±0.61	3.72±0.61	3.76±0.59	3.80±0.76
Taste [NS]	3.40±0.86	3.44±0.86	3.48±0.87	3.40±0.76
Acceptability [NS]	3.60±0.64	3.64±0.70	3.72±0.54	3.64±0.63

Results are expressed as mean±SD.

[NS] Not significantly different ($p>0.05$)