Application of conventional, vacuum, and retort packaging on the physicochemical and sensory evaluation of ready-to-eat (RTE) ayam kalasan at ambient temperature during two weeks

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Abstract. This study was aimed to compare physicochemical, sensory, and shelf life of ready-to-eat (RTE) ayam kalasan, one of indigenous fried chicken from Indonesia using three different packaging. The treatment of packaging materials were P0 (conventional packaging), P1 (vacuum packaging), and P2 (retort packaging). Shelf life test was conducted at 0 and 2 weeks with triplication for each samples. The parameters tested were physicochemical and sensory evaluation. Physicochemical tests were pH, water holding capacity (WHC), tenderness, and proximate analysis (water, collagen, protein, and fat). Sensory parameters which were analyzed namely color, taste, texture, flavor, and tenderness. Data were analyzed using factorial analysis 3 x 2 combined with Duncan test. The results showed that the packaging material with three different methods produced different physicochemical and sensory qualities. The pH value were ranged from 5.96-6.18, WHC at 35.00%-49.30%, and tenderness at 1.94 kg/cm²-3.08 kg/cm². Results showed that chemical parameters among different packaging ranged from 1.84%-2.15% for collagen, 6.94%-7.62% for fat, 59.40%-67.31% for water, and 24.13%-28.02% for protein. The sensory parameters including color, taste, texture, flavor, and tenderness ranged from 3.20-4.36; 3.73-3.90; 3.73-3.90; 3.10-3.82; and 3.00-4.00 respectively. This preliminary data could be used for further research related longer shelf life of RTE ayam kalasan.

1. Introduction

RTE Ayam kalasan is a typical fried chicken from Kalasan, Yogyakarta cooked in whole chicken with addition of special spices. The complete nutrition content of ayam kalasan causes chickens to be easily damaged both physically, microbologically and physically. Preservation process is needed to maintain the shelf life.

One method of preserving RTE ayam kalasan is the packaging process. Packaging is coordinated system to prepare product to be transported, distributed, and also gives longer shelf life, can be sold either be used. Packaging can protect product from contamination and other sources which can damage product. Packaging functions to extend shelf life and maintain the quality of the material longer because the packaging is able to prevent or reduce damage, protect the material inside from pollution and physical disturbances such as friction, impact, and vibration. Syarief and Halid [1] said that vacuum packaging is packaging by removing gas and water vapor from packaged products, while...
non-vacuum packaging is carried out without removing gas and water vapor contained in the product. Vacuum packaging serves to reduce bacteria, changes in odor, taste, and appearance during storage, because under vacuum conditions, aerobic bacteria that grow in number are relatively smaller than in non-vacuum conditions.

Retort pouch is a flexible package form a pouch or bag that is used to package ready-to-eat food products. The packaging made from aluminun foil and polymer laminates, resistant to the sterilization process [2]. A thin retort pouch makes it possible to reduce heating time, thus avoiding over cooking. In addition, the products produced have better color, compact texture, and no nutrient shrinkage [3]. Mistakes in selecting methods and packaging materials can reduce the value of perishable products, easily contaminated with bacteria and fungi. This study aimed to determine the suitable packaging to maintain shelf life of RTE ayam kalasan at ambient temperature in Indonesia.

2. Material and methods

2.1. Sample preparation
Samples needed for this research were 15 samples of whole chicken ayam kalasan. Whole chicken was cleaned and marinated for about two hours than fried with coconut oil. Samples then packed using three different packaging materials which were P0 (n=5) (conventional packaging), P1 (n=5) (vacuum packaging), and P2 (n=5) (retort packaging) then the sample was sterilized used the All American model 1925X temperature above 121°C, pressure at 15 psi for 15 minutes. Samples were then stored at ± 28°C and tested at 0, 2, 4, 6, and 8 weeks with three replications for each parameter. The parameters tested were physicochemical and sensory quality of color, taste, texture, flavor, and tenderness.

2.2. Proximate analysis
Chemical analysis method for this research were water, fat, protein, and collagen content by using a food scan NIRS (Near Infrared Reflectance Spectroscopy) food scanner. Thirty grams of sample were grinded, and checked in food scanner with a special petri dish. Samples checked in triplication.

2.3. pH value
pH value was checked by using pH meter. Samples of 2 g were chopped then dissolved homogeneously in distilled water (18 ml). pH meter calibrated by using probe dissolved in pH 4 and 7 buffer solution until the value was constant. Measurements were repeated in triplicates.

2.4. Water holding capacity
The analysis of the water holding capacity (WHC) in this research using the method of Hamm [4]. Samples in amount of 0.3 gr placed on filter paper and press between 2 glass plates, and then given 35 kg load for 5 min. The area which absorbed water was then counted with planimeter. WHC or free water percentage then calculated with the following formula:

\[
\text{mgH}_2\text{O} = \frac{\text{wet area (cm}^2\text{)}}{0.0948} \times 8
\]

\[
\% \text{ free water} = \frac{\frac{\text{mgH}_2\text{O}}{\text{sample weight (mg)}}}{100}\%
\]

The sample used for water content assay was 1 g. Weighed samples then inserted into filter paper and ovened at 105°C for 24 hours. Dried samples were then taken and weighed by using formula according to Dewi [5] as follows:
TWC = \( \frac{x + y - z}{x} \times 100\% \)

Details:
X = Sample weight
Y = filter paper weight
Z = Sample weight + filter paper weight after being oven.
TWC = Total Water Content
%WHC = TWC - % free water

2.5. Tenderness
Samples of chicken with a thickness of 0.5 cm and 1.5 cm width were placed on the Warner-Bratzel machine. Triplication of samples were then applied, and the average was collected.

2.6. Sensory analysis
A total of 11 male and female semi-trained panelists aged 17-21 years conducted a sensory analysis for *ayam kalasan*. The panelists have been trained every two weeks before analyzing the characteristics of *ayam kalasan* during storage. Sensory procedures are explained in detail to the panelists before conducting a sensory test. A pack questionnaire was given to be filled during a sensory analysis. Every sample was labeled 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. Panelists are required to rinse their mouth after the analysis for each different sample [3]. This procedures were designed to avoid cross-contamination of the sensory characteristics in each sample. Furthermore, the panelist 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 flavor. The sensory analysis was observed during storage at 0, 2, 4, 6, and 8 weeks. Parameter scales were set at; 5: very like, 4: Like, 3: plain 2: dislike, and 1: very dislikes.

2.7. Statistic analysis
All data were analyzed with SPSS statistical package software by One-way analysis of variance method to determine the effect of packaging and storage (SPSS version 16). Comparisons among groups were then analyzed using Duncan multiple range tests (significance at p < 0.05).

3. Results and discussion
Results of proximate analysis could be seen at Table 1. The results showed that packaging treatments with storage time on RTE *ayam kalasan* significantly affected (P<0.05) to water, protein, fat, and collagen contents. RTE *ayam kalasan* in conventional packaging at ambient temperature caused high microbial growth so that it could easily degraded protein, moreover water content became low. The longer storage also showed the lower water content. This might be caused by protein degradation as a resulted of growth bacteria. The result of this phenomenon was outing water from the product and decreasing water content. Dewi [6] stated that main component which has function to hold water of the meat is protein. Collagen degradation from protein which composed meat’s fiber bonding could affect potency of those water holding capacity.

3.1. pH value
Table 2 shows the pH change of *ayam kalasan* during the storage at ambient temperature (28-30°C). In this assay, the samples’ pH decreased in all treatments. Duration of storage decreased pH value.

3.2. Water holding capacity
Water holding capacity (WHC) by term, is the ability of water to bind proteins. The WHC values of RTE *ayam kalasan* were showed in Table 2. The holding capacity of water during the storage was
significantly different (P<0.05). Denaturation in this regard, weakened protein structure and decreased water holding capacity. Lestarini et al. [7] stated that ability of water holding capacity decreased at 16 hours storage time. Decreasing the holding capacity of water during storage occurs due to changes in protein structure. Utami et al. [8] informed that changes in water holding capacity are caused by changes in meat protein solubility due to protein denaturation.

### Table 1. Proximate analysis of ayam kalasan with conventional, vacuum, and retort packaging during storage at ambient temperature

| Proximate composition | Storage time (day)* | Treatments                  | Conventional (Sterilized) | Vacuum (Sterilized) | Retort (Sterilized) |
|-----------------------|---------------------|------------------------------|----------------------------|---------------------|---------------------|
| Moisture              | 0                   | 59.44±0.11<sup>aA</sup>     | 67.31±0.30<sup>bA</sup>   | 66.89±0.26<sup>cA</sup> |
|                       | 14                  | 52.99±0.09<sup>bB</sup>     | 51.26±0.23<sup>cB</sup>   | 53.47±0.04<sup>cB</sup> |
| Protein               | 0                   | 28.02±0.12<sup>cB</sup>     | 24.42±0.72<sup>cB</sup>   | 24.13±0.50<sup>cB</sup> |
|                       | 14                  | 27.19±0.10<sup>cB</sup>     | 29.48±0.17<sup>cB</sup>   | 25.06±0.05<sup>cB</sup> |
| Fat                   | 0                   | 7.62±0.09<sup>cB</sup>      | 7.20±0.18<sup>cB</sup>    | 7.21±0.60<sup>cB</sup> |
|                       | 14                  | 11.37±0.01<sup>cB</sup>     | 10.28±0.04<sup>cB</sup>   | 8.20±0.64<sup>cB</sup> |
| Colagen               | 0                   | 2.15±0.05<sup>cB</sup>      | 1.84±0.10<sup>cB</sup>    | 1.94±0.15<sup>cB</sup> |
|                       | 14                  | 2.64±0.11<sup>cB</sup>      | 2.40±0.03<sup>cB</sup>    | 2.63±0.16<sup>cB</sup> |

*Storage at 28°C room temperature
<sup>a,b,c</sup> Different superscripts at the same row indicate significantly differences (P<0.05)
<sup>A,B,C</sup> Different superscripts at the same column indicate significantly differences (P<0.05)

#### 3.3. Tenderness

The tenderness value of this product could be seen in Table 2. Results showed that the packaging treatments significantly affected (P<0.05) tenderness. Factor which might be affected the result was because the meat protein is denatured by the long storage so the protein can not bind the water and it causes the tenderness value become high. Whole meat carcass structure was different from restructured meat-based products. Komariah et al. [9] stated that the main components affecting tenderness are connective tissue groups meat fiber groups, and muscle-related fatty groups.

#### 3.4. Color

Color is important parameter to define quality of food products. Statistical result from RTE ayam kalasan’s color characteristic related with packaging treatments and storage time showed significantly different (P<0.05). Based on table 2, it showed that conventional packaging were very susceptible in color change. Change in color from in this regards, caused by chemical process as a result of increment of aerobic bacteria. Soeparno [4] showed that chemical changes in meat and color changes in meat caused by microbia activity. Storage time will increase microbia growth.

#### 3.5. Taste

Taste is a sensory parameter to determine the acceptability of food product to consumers. The results showed that different packaging treatments and storage time significantly affected the quality of RTE ayam kalasan. P2 showed the highest value among treatments, while P0 was the lowest. Sensory analysis results related taste of ayam kalasan were 3.29 and 2.93 for P1 and for P2, which means the panelists like it, while P0 shows at 2.22 dislike value. The control treatment showed very different result due to the decay process after 2 weeks, result in an inedible product. Winarno [10] confirmed that taste perception greatly influenced by tongue sensitivity and other factors such as; chemical compounds, temperature, concentration, and other taste components. Moreover, taste is also formed from combination of food ingredients.
3.6. Texture
Texture is a parameter that describes the softness or smoothness of food. The results showed that the texture had a significant effect (P<0.05) due to different packaging and storage time. Control (P0) showed a value at 2.33 (dislike), P1 at 3.27 (like), and P2 at 3.40 which means plain to like. Furthermore, the texture value during 2 weeks storage were ±3.70 (very like). Sumual showed a value at 2.33 (dislike), P1 at 3.27 (like), and P2 at 3.40 which means plain to like. Texture had a significant effect (P<0.05) due to different packaging and storage time. Control (P0) informed that food texture can be determined by tasting it using mouth, teeth or tongue organs.

3.7. Flavor
Result showed that different packaging treatments in 2 weeks storage significantly affect among treatments (P<0.05). P2 showed the highest value at 3.70; P1 at 3.45; and P0 at 2.22. The flavor produced from volatile substances is catched by smell receptor in the back of nose and then it is interpreted by the brain [12]. Factors that affected flavor of meat products are cooking type, cooking time, and cooking temperature. Flavor of meat product also can be affected by the ingredients added during the making process of the meat processed product especially the seasoning [10].

### Table 2. Changes in physics (pH value, Texture analysis, WHC) and sensory characteristics with conventional, vacuum, and retort packaging during storage at ambient temperature

| Parameters  | Storage Time (day)* | Samples                                      |                  |                  |
|-------------|---------------------|----------------------------------------------|------------------|------------------|
|             |                     | Conventional (Sterilized)                     | Vacuum (Sterilized) | Retort (Sterilized) |
| pH value    | 0                   | 6.17±0.13<sup>aA</sup>                       | 6.10±0.12<sup>bA</sup> | 5.96±0.07<sup>AB</sup> |
|             | 14                  | 6.00±0.14<sup>AB</sup>                       | 5.75±0.09<sup>AB</sup> | 6.00±0.01<sup>AB</sup> |
| Texture     | 0                   | 3.44±0.23<sup>bB</sup>                       | 2.55±0.14<sup>aA</sup> | 2.71±0.13<sup>aA</sup> |
| analysis    | 14                  | 8.23±0.15<sup>aA</sup>                       | 2.35±0.11<sup>bB</sup> | 2.28±0.06<sup>bB</sup> |
| WHC         | 0                   | 48.76±0.49<sup>aA</sup>                      | 36.15±0.52<sup>aA</sup> | 37.25±0.90<sup>aA</sup> |
|             | 14                  | 26.33±2.52<sup>bB</sup>                      | 29.67±1.53<sup>bB</sup> | 22.10±3.02<sup>bB</sup> |
| Taste       | 0                   | 3.38±0.07<sup>aA</sup>                       | 3.37±0.04<sup>aA</sup> | 3.30±0.05<sup>aA</sup> |
|             | 14                  | 1.07±0.06<sup>aB</sup>                       | 3.21±0.09<sup>aB</sup> | 3.24±0.08<sup>aB</sup> |
| Color       | 0                   | 3.42±0.03<sup>aA</sup>                       | 4.05±0.05<sup>aA</sup> | 2.80±0.06<sup>aA</sup> |
|             | 14                  | 1.00±0.00<sup>aB</sup>                       | 2.40±0.03<sup>aB</sup> | 2.63±0.16<sup>aB</sup> |
| Texture     | 0                   | 3.58±0.04<sup>aA</sup>                       | 3.35±0.11<sup>aA</sup> | 3.42±0.04<sup>aA</sup> |
|             | 14                  | 1.08±0.04<sup>aB</sup>                       | 3.20±0.04<sup>aB</sup> | 3.38±0.03<sup>aB</sup> |
| Flavor      | 0                   | 3.38±0.03<sup>aA</sup>                       | 3.17±0.07<sup>aA</sup> | 2.97±0.05<sup>aA</sup> |
|             | 14                  | 1.35±0.10<sup>bB</sup>                       | 3.06±0.12<sup>bB</sup> | 3.71±0.20<sup>bB</sup> |
| Tenderness  | 0                   | 3.42±0.03<sup>aA</sup>                       | 3.57±0.04<sup>aA</sup> | 3.78±0.18<sup>aA</sup> |
|             | 14                  | 1.04±0.05<sup>aB</sup>                       | 3.34±0.09<sup>aB</sup> | 3.64±0.09<sup>aB</sup> |

*Storage at 28°C room temperature
<sup>a,b</sup>. Different superscripts at the same row indicate significantly differences (P<0.05)
<sup>A,B</sup,C. Different superscripts at the same column indicate significantly differences (P<0.05)

4. Conclusion
It could be concluded that vacuum and retort packaging significantly affected water, protein, fat, tenderness, water holding capacity and sensory. However, collagen and pH in conventional and vacuum treatment were not significantly different during 2 weeks storage. This research showed the initial physical and sensorial data of RTE ayam kalasan which could support further experiment. Vacuum and retort pouch packaging could be used as RTE ayam kalasan packaging. Further research at 4, 6, and 8 weeks is needed to understand more about ayam kalasan characteristics and shelf life during storage at ambient temperature.
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