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The pH, water-holding capacity, cooking loss and tenderness of spent layer meat influenced by marination duration using *Garcinia xanthochymus* fruit paste

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Abstract
The meat of spent layers has lower physical quality compared to broiler chickens because of the tough texture, so a post-harvvest method is needed to improve its tenderness. One tenderizing method is marination using acidic fruit paste. The objective of this study was to determine the duration effect of marination using kandis fruit (*Garcinia xanthochymus*) paste on pH, water-holding capacity, cooking loss and tenderness of spent layer meat. Thi study was carried out experimentally using a completely randomized design with 4 marination duration treatments (0, 15, 30 and 45 minutes) and with 5 replications. Data were analyzed using analysis of variance and followed by Duncan's multiple range test. The results showed that marination using *Garcinia xanthochymus* fruit paste affected the pH value ($P<0.05$), water-holding capacity ($P<0.05$) and tenderness, but did not affect cooking loss of spent layer meat. The optimal marination time was 45 minutes with a pH value of 4.53, a water-holding capacity of 42.63%, cooking loss of 36.31% and tenderness value of 41.12 mm/g/10 seconds.

Keywords: Kandis fruit, marination, pH, spent layer meat, tenderness

Introduction

Spent layers or culled laying hens are laying hens whose egg production is no longer economically profitable for production, because their production is limited to around 20-25% (Gillespie and Flanders, 2010) [3] and has an average age of 72-80 weeks (Murtidjo, 2003) [9]. The meat of spent layers is of low quality because they are slaughtered at a relatively old age so the tenderness of the meat is lower and is less liked by the public (Rasyaf, 2010) [14]. One way to tenderize the meat of spent layers is to use a meat tenderizer (Purnamasari *et al*., 2012) [13].

One treatment that can be carried out is the marination process. Soaking or marinating is the process of soaking meat in marinade ingredients. Marinade is a seasoned solution that functions as a meat marinade, usually used to improve the taste, juice impression and tenderness of the meat after cooking. Marinade ingredients can include acids (vinegar and lemon juice), edible oils (olive and almond) and spices (Nurwantoro *et al*., 2012) [10]. Based on research conducted by Alvarado and Sams (2003) [2], the marination process is useful for improving the taste and tenderness of meat, reducing cooking losses and increasing the shelf life of meat. There are various types of marination, one of which is acid-based marination which can be used to tenderize meat because it has the effect of cutting protein or meat fiber.

Kandis fruit (*Garcinia xanthochymus*) belongs to the genus *Garcinia* plants which are distributed in tropical areas of Asia. In Indonesia, kandis fruit is widely found in Kalimantan, Sumatra, Java and Bali (Heyne, 1987) [4]. Kandis fruit is one of the cooking spices that is widely used as a substitute for Javanese acid, especially in dishes in Sumatra. Kandis fruit fruit contains the ethyl acetate fraction which contains secondary metabolic compounds such as phenolics, flavonoids, alkaloids and saponins, and has a role as a cytotoxic and antibacterial antioxidant (Tursiman *et al*., 2012) [18].

Kandis fruit contains the main organic acid, namely hydroxycitric acid (hydroxyl citric acid) which can cause the pH in a solution to become acidic or cause a decrease in the pH value (Lucida *et al.*, 2012) [6]. The decrease in pH caused by the addition of acid contained in kandis fruit to meat has the potential to affect the physical quality of the meat. Therefore, this research aims to determine the effect of marinating time with kandis fruit paste on pH, water-holding capacity, cooking loss and tenderness of meat from spent layers, as well as to determine the relationship between the pH value of the meat and the percentage of water holding capacity and tenderness value.

Materials and methods

Kandis fruit paste preparation

Dried kandis fruit was used as a marinade ingredient. Kandis fruit was ground with the addition of distilled water as a mixture to make kandis fruit paste at a ratio of 1:2. After the grinding was complete, the mixture of kandis fruit and distilled water was cooked at a temperature of ± 80°C for 30 minutes and continued to stir until it thickened and becam a paste.

Meat marination

The meat came from 10 culled ISA Brown laying hens aged 72-80 weeks which had an average body weight of 1.78 kg with a coefficient of variance of 6.62%. The samples used left and right breast meat to obtain a total of 20 samples.

Kandis fruit paste with a concentration of 20% of the weight of the meat was smeared on the surface of the meat and put in a zipper plastic bag. The meat was marinated for 15 minutes, 30 minutes and 45 minutes at room temperature. After the marination time was complete, the meat samples were rinsed with distilled water, then continued with measurement for pH, water-holding capacity, cooking loss and tenderness.

Measurement of pH

pH measurement was performed using a digital meat pH meter (YY-1030) in triplicates. The pH meter electrode/probe was calibrated with buffer pH 10, 4, and 7 sequentially before use. The pH meter electrode/probe was inserted into the meat until digital numbers appeared on the screen and the data was recorded when it was stable.

Water-holding capacity determination

Method of Soeparno (2005) was used to measure waterholding capacity in this research. A meat sample weighing 0.3 grams was placed on a Whatman filter paper No. 42 and pressed between two glass plates loaded with a load of 35 kg for 5 minutes. After that, the total wet area and meat area were measured. Meat moisture content was determined according to the method of Muchtadi *et al*. (2010) [8] using an oven at a temperature of 105℃. Until the weight loss (%) was obtained which was used as water content. Waterholding capacity was measured using the following formula

$$WHC = moisture\ content\ (\%) - \frac{mg\ H_2O}{300\ mg} \times 100\%$$

Cooking loss measurement

Cooking loss was measured using the weight loss percentage method (Soeparno, 2005) in triplicates. The sample was weighed at 30 grams, then put in a zipper bag and boiled in water bath at 80– 82℃ for ± 30 minutes. Once finished, samples were cooled at room temperature until the weight was stable then weighed. The cooking loss percentage was calculated using the following formula

$$Cooking\ loss\ (\%) = \frac{Initial\ weight\ (g) - Final\ weight\ (g)}{Initial\ weight\ (g)} \times 100\%$$

Tenderness measurement

Determination of meat tenderness was carried out using a Pearson and Dutson (1994) [12] penetrometer method. Meat samples were cut uniformly weighing 30 grams. Next, the meat was boiled for 30 minutes at a temperature of 80℃ ro 82℃, then cooled to room temperature. The meat was placed directly under the penetrometer needle. Ten measurements of each sample were carried out at different points and then averaged in units of mm/g/10 s.

Statistical analysis

Data were analyzed using one-way analysis of variance (ANOVA). If the results showed a significant effect, then the analysis was continued with Duncan's multiple range test to separate the means at the 95% confidence level. Simple linear regression analysis was used to determine the relationship between the pH value of meat and its tenderness.

Results and discussion

pH value

The test results showed that the average pH value of meat was the lowest, namely 4.53 in the marinating treatment for 45 minutes, while the highest average pH value of meat was 5.80 in the treatment without marinating. The significance results show a real difference in the pH value which decreases with the length of marination time.

Kandis fruit has a low pH content which is thought to cause increased acidity and decreased pH in meat. The low pH in meat causes the water binding capacity to be lower (Zulfahmi *et al.*, 2013) [19]. The results of this research are in line with research by Patriani & Wahyuni (2019) [11] which states that the meat of rejected laying hens that are marinated using acid-based spices such as kandis fruit will experience a decrease in pH value and have a lower pH than chicken meat without treatment or control.

Water-holding capacity

The test results showed that the average percentage of water-holding capacity of meat was the highest, namely 49.35% in samples without treatment, while the average percentage of water holding capacity of meat was the lowest, namely 36.07% in the marinating treatment for 30 minutes. The significance results show that the marinating treatment for 15 minutes and 30 minutes is not significantly different, but the difference is significantly lower compared to the treatment without marinating and marinating for 45 minutes.

The decrease in water holding capacity can be caused by the acid content in kandis fruit paste which is thought to reduce the pH of the meat. This triggers the cathepsin enzyme to loosen the contraction of the actomyosin. The decrease in the pH value causes the cathepsin enzyme which is a proteolytic enzyme to become active so that it can loosen the protein structure of the fiber. meat (Lonergan *et al*., 2010) [5]. An acidic pH value can weaken the myofibril bonds in meat and result in more free water coming out of the meat (Trevisian and Brum, 2020). The difference in the value of the water binding capacity of meat is influenced by the protein and carbohydrate content of the meat, low protein content in meat will be followed by lower water-holding capacity (Risnajati, 2010) [15].

Cooking loss

The measurement results from various long marination treatments show that the average percentage of meat cooking loss ranges from 32.65% - 36.61%. Statistical tests were carried out using analysis of variance to determine the extent of the effect of treatment. The results of the analysis of variance showed that the length of marination using kandis fruit paste had no significant effect. Therefore, Duncan's follow-up test could not be carried out to determine the effect between treatments on cooking loss.

Marinating the meat of cull laying hens using kandis fruit paste does not have a good effect on cooking losses because meat with low water holding capacity will cause a lot of liquid to be lost, so that during cooking there will be a large loss of weight (Aberle *et al*., 2001) [1]. This can cause the cooking loss value of the meat to be greater and cause the meat to lose more nutrients during the cooking process. Patriani and Wahyuni (2019) [11] stated that marinating meat using acid from natural fruit can cause meat fat to dissolve, but has no real effect on increasing cooking losses.

Tenderness

The test results showed that the highest average value of meat tenderness was 41.12 in the marinating treatment for 45 minutes, while the lowest average value of meat tenderness was 30.38 in samples without treatment. The tenderness value increases with the length of marination

time. The significance results showed that the 45 minute and 30 minute marination treatments were not significantly different, but the significant difference was higher with the no marination and 15 minute marination treatments.

The real difference between the marination time treatments of 15 minutes, 30 minutes and no treatment was due to the level of treatment time for the meat. According to Soeparno (2015) [16], meat tenderness is determined by three components of meat, namely the myofibril structure and its contraction structure, the connective tissue content and the level of cross-linking, the water holding capacity of meat proteins and meat juice. The longer the marination treatment is given, the faster the protein hydrolysis process with protease enzymes. Mohd Azmi *et al*. (2023) [7] stated that protease enzymes in plants have been proven to be able to increase meat tenderness through a proteolytic degradation mechanism. Protease enzymes function to tenderize meat, because proteins in connective tissue and myofibril fragmentation experience degradation so that they are hydrolyzed.

Tabel 1: pH value of spent layer meat before and after marination using kandis fruit paste

Marination duration (minutes)	pH value
0	5.82±0.06^{d}
15	5.00±0.10^{c}
30	4.71±0.10^{b}
45	4.59±0.08^{a}

Different letters in the superscript indicate significant differences (P<0.05).

Tabel 2: Water-holding capacity of spent layer meat before and after marination using kandis fruit paste

Marination duration (minutes)	Water-holding capacity (%)
0	49.35±11.06^{a}
15	36.86±4.15^{b}
30	36.07±341^{c}
45	42.63±5.81^{c}

Data are presented as mean±standard deviation.

Different letters in the superscript indicate significant differences (P<0.05).

Tabel 3: Cooking loss of spent layer meat before and after marination using kandis fruit paste

Marination duration (minutes)	Cooking loss (%)
0	32.65±2.77
15	35.40±2.39
30	35.89±2.39
45	36.31±2.73

Data are presented as mean±standard deviation.

Tabel 4: Tenderness of spent layer meat before and after marination using kandis fruit paste

Marination duration (minutes)	Tenderness (mm/g/10 seconds)
0	30,38±3,14^{a}
15	36,08±4,14^{a}
30	40,20±1,60^{b}
45	41,12±1,47^{c}

Data are presented as mean±standard deviation.

Different letters in the superscript indicate significant differences (P<0.05).

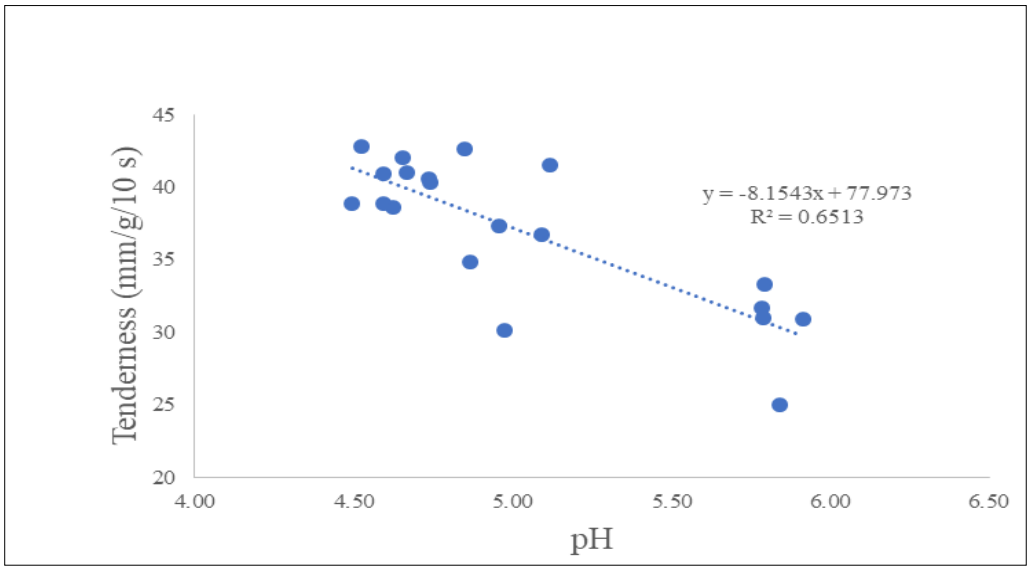

Fig 1: Linear regression between pH value and tenderness of spent layer meat marinated using kandis fruit paste.

Conclusion

Marination using kandis fruit (*Garcinia xanthochymus*) paste for different durations until 45 minutes affected the pH value, water-holding capacity and tenderness, but did not affect cooking loss of spent layer meat. The optimal marination time was 45 minutes with a pH value of 4.53, water-holding capacity of 42.63%, cooking loss of 36.31% and tenderness value of 41.12 mm/g/10 seconds.

Conflict of Interest

The authors declare that they have no conflict of interest

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Ethical approval

This study was approved by the Institutional Ethics Committee of Universitas Padjadjaran.

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