Effect of Gelugur acid extract (Garcinia atroviridis) on the physical quality of culled chicken meat at different shelf life

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Abstract. This study aims to find out the interaction between the percentage of Garcinia atroviridis extract and the shelf life of the physical quality culled chicken meats. This study used a complete randomized design of factorial patterns. The first factor is the concentration of Garcinia atroviridis extracts (P0:0%, P1:3%, P2:6% and P3:9%). The second factor is the shelf life at (T1:24 hours and T2:48 hours). The data was analysed using a nova and if there was a noticeable difference will be continued using Duncan tests. The results showed that there was an interaction (P˂0.01) between the increase of Garcinia atroviridis P1, P2, and P3 in the shelf life of T1 and T2 against pH, cooking loss, meat moisture content. However, there is no interaction (P ˃0.05) between Garcinia atroviridis in shelf life against the drip loss of meat. The higher Garcinia atroviridis extract will lead to decreased pH value, lower cooking loss value, and increase meat moisture content. The results showed the physical quality of culled chicken meat was still in the normal range. The use of Garcinia atroviridis extract 3% is recommended to improve the physical quality of culled chicken meat at a shelf life of 24 to 48 hours.

1. Introduction

Culled chicken meat is a meat that has a lower quality when compared to broiler chicken meat. The physical quality of meat affects consumption patterns, especially on consumers' preferences. Also, the physical quality of meat is an indication to know if the meat is worth consuming and processed. Culled chicken meat has various drawbacks that are low quality compared to broiler chicken, have a specific smell, have a high level of tenderness.

Various efforts to improve the quality of chicken meat to increase consumer preferences need to be done. In addition to this, changes in the physical quality of chicken meat also need to get attention. Chicken meat is easily decayed because it contains a protein high enough to accelerate the growth of microbes. Various methods to improve meat quality and extend shelf life include using preservatives such as sodium nitrate, benzoate, and borax [1]. But long-term use can affect consumer health. Methods of cooling and using ice cubes can also be done, but not all regions in Indonesia have stable electrical power so the price of ice cubes is quite expensive.

The use of natural ingredients to improve the quality and extend the shelf life of meat is one of the alternatives. Gelugur acid (Garcinia atroviridis) is a spice available year-round and available in traditional markets. Garcinia atroviridis is a freshly sour fruit found in various countries of southern Thailand, Malaysia, India, and Indonesia [2]. Garcinia atroviridis has the activity of antioxidant and...
anti-microbial compounds that have been widely used in medicine [3]. This means the use of Garcinia atroviridis can provide side effects of additional antioxidant properties for chicken meat.

Various studies on the benefits of Gelugur acid (Garcinia atroviridis) containing anti-microbial compounds such as Garcinia xanthone, ascorbic acid [4], anti-fungal and anti-tumour [5], antioxidants, phenolic [6], Flavonoids [7] and fruit acids namely citric acid, tartrate, ascorbic [8-11]. The content of compounds that have many of these benefits is the potential that has not been studied as a natural preservative that can extend the shelf life while also improving the quality of culled chicken meat. According to [12,13] stated that the addition of organic acids such as citric acid in poultry meat could extend shelf life.

This study aims to find out the interaction between the percentage of Garcinia atroviridis extract and the shelf life of the physical quality of the culled chicken meat. The physical quality of chicken meat in this study was pH, moisture content, cooking loss, and drip loss.

2. Materials and methods

This research was conducted at the Laboratory of Livestock Production and Organic Chemistry Laboratory of Mathematics and the Natural Science University of North Sumatra. This study used a complete randomized design of factorial patterns. The first factor was the concentration of Garcinia atroviridis extract (P0= 0%, P1=3%, P2=6%, and P3=9%) and the second factor was the shelf life (T1=24 hours and T2=48 hours) with 5 replications. The determination of the data obtained was analysed using ANOVA and if there was a real difference will be continued using the Duncan test.

The materials and tools used in this study were culled chicken meat, Garcinia atroviridis, aquadest, Kcl, ethanol 70%, filter paper, alcohol, extraction toolset, tissue, pH meter, Moisture meter meat, cooking utensils, knives, digital scales, plastic bags, wires, pipes, plastic bags, ropes, and meat knives. Each treatment was repeated 4 replays. Culled chicken meat used for samples weighing 20 grams.

Garcinia atroviridis extraction was by drying garcinia atroviridis dried then smoothed until it becomes powder. The extraction of gelugur acid using the method of maceration with solvents used was a 70% ethanol solvent. It was then tightened with a rotary evaporator with a temperature of 40ºC-60ºC until it was obtained extract liquid [14,15]. The methods of measuring parameters in this study were:

2.1. pH measurement

Measurement of 10-20 grams meat pH sample. Measurement of the pH of meat using a digital pH meter [16]. The measurement of meat pH was by soaking the sensor needle in the previous Kcl and aqua dest, then pierced into the meat that has been marinated according to the treatment.

2.2. Cooking loss measurement

Cooking loss measurement using the CSIRO method. The meat was weighed as much as 20 grams, then put in plastic and tied. The meat was then boiled for 30 minutes at 80°C and weighed the final weight [17]. Cooking loss was calculated using the formula:

\[
\text{Cooking loss (\%)} = \left( \frac{\text{Meat weight before boiling (gram)} - \text{Weight of meat after boiling}}{\text{Meat weight before boiling}} \right) \times 100\%
\]  
(1)

2.3. Water content measurement

Measurement of moisture content using a digital moisture meter tool. A sample of 20 grams of meat that had been marinated according to the treatment was punctured using a needle sensor tool moisture meter. Let stand for a while until the monitor screen displayed the percentage of the sampled meat moisture content.
2.4. Drip loss measurement
Drip loss measurement using bag method [15]. Samples weighed using digital scales were hung then water droplets were accommodated in plastic after 24 hours and 48 hours the samples were weighed back. Drip loss can be measured using the following formula:

\[
\text{Drip loss (\%)} = \frac{\text{weight before the meat is hung} - \text{Meat weight after hanging}}{\text{Meat weight before hanging}} \times 100\%
\]

3. Results and discussion
The results of the study on the quality test of chicken meat that has been marinated using *Garcinia atroviridis* extract included meat pH test, cooking loss, moisture content, and drip loss.

3.1. Meat pH value
pH values based on marinated analysis of *Garcinia atroviridis* with percentages of 0%, 3%, 6% and 9% on 24-hour and 48-hour shelf life can be seen in Table 1. The average pH value of chicken laying meat marinated in *Garcinia atroviridis* extract solution at a percentage of 0%, 3%, 6%, and 9% was 5.74, respectively; 5.70; 5.59, and 5.49. Statistical analysis showed that chicken meat marinated using *Garcinia atroviridis* made a very noticeable difference to the pH value of meat (P<0.01). The results showed that the pH value of chicken meat marinated with *Garcinia atroviridis* extract had different values in each treatment. The pH value of meat showed a decrease with an increasing percentage of *Garcinia atroviridis* extracts. This was due to the increase in the percentage of *Garcinia atroviridis* extracts causing protein denaturation due to citric acid. Hydrolysis of acidic liquid can occur so that it entered the meat osmosis. Protein denaturation can cause hydrophobic meat proteins to come out with the liquid phase. This was the cause of the higher percentage of *Garcinia atroviridis* causing the lower the pH value of meat due to the absence of acid hydrolysis.

| Storage Time | Extract *Garcinia Atroviridis* (%) | Average |
|--------------|-------------------------------------|---------|
| T1 (24 Hour) | P0 (0%) 5.86±0.54<sup>d</sup>       | 5.69±0.14<sup>b</sup> |
|              | P1 (3%) 5.77±0.23<sup>c</sup>       |         |
|              | P2 (6%) 5.63±0.25<sup>b</sup>       |         |
|              | P3 (9%) 5.49±0.58<sup>a</sup>       |         |
| Average      | 5.62±0.85<sup>b</sup> 5.64±0.54<sup>b</sup> 5.54±0.47<sup>a</sup> 5.50 ±0.48<sup>a</sup> 5.57±0.81<sup>a</sup> |

Note: Different superscripts in the same row or column showed a very noticeable difference (P<0.01)

Statistical analysis showed the pH value of Culled chicken meat with a difference in shelf life gave a very noticeable difference (P<0.01) at T1 of 5.69 and T2 of 5.57 this meant the longer storage time can increase the pH value of meat. Statistical analysis showed that there was an interaction between the percentage increase of *Garcinia atroviridis* to the shelf life of the meat pH value (P<0.01). At the same shelf life and the percentage increase of *Garcinia atroviridis*, it caused acidic substances in *Garcinia atroviridis* to enter the meat. The higher percentage of *Garcinia atroviridis* extracts made the levels of citric acid and ascorbic acid in *Garcinia atroviridis* also increase. Interactions occurred at a percentage of *Garcinia atroviridis* extracts of 3% at a shelf life of 24 hours and 48 hours. In *Garcinia atroviridis* extract a percentage of 3% already causes a decrease in the pH value of meat in the shelf life of 24 hours or 48 hours. This was thought to be due to the entry of acidic substances into the meat so that there was an interaction with the content of water in the meat. According [16] normal meat pH value between 5.76 light-coloured and 5.93 dark-coloured meats. According to [14] that the normal pH value in meat was about 5.3-5.8 so that it can be inferred the pH value in the marination using Gelugur acid was still within the normal range. Marinating uses 3% still lasted a shelf life of 48 hours so it can be recommended.
3.2. Meat cooking loss

The results of statistical analysis of hen laying meat marinated in Garcinia atroviridis extract at a percentage of 0%, 3%, 6%, and 9% in the shelf life of 24 hours to 48 hours were shown in Table 2. The average cooking loss value of marinated chicken meat using Garcinia atroviridis at a percentage of 0%, 3%, 6%, 9% is 29.51, respectively; 24.41; 25.75, and 25.39%. Statistical analysis showed that chicken meat marinated using Garcinia atroviridis extract has a very noticeable influence on the percentage of cooking loss (P˂0.01). The data showed that cooking loss of chicken meat marinated using Garcinia atroviridis extract each had a very real different score.

| Storage Time | Extract Garcinia Atroviridis (%) |   |   |   | Average   |
|--------------|---------------------------------|---|---|---|-----------|
| T1 (24 Hour) | P0 (0%)                         | 28.60±0.87<sup>d</sup> | 24.48±0.77<sup>ab</sup> | 25.98±0.58<sup>c</sup> | 25.34±0.70<sup>abc</sup> | 26.10±1.71<sup>a</sup> |
| T2 (48 Hour) | P1 (3%)                         | 30.42±0.74<sup>e</sup> | 24.34±0.79<sup>a</sup> | 25.52±0.77<sup>b</sup> | 25.44±0.95<sup>bc</sup> | 26.43±2.52<sup>ab</sup> |
| Average      |                                | 29.51±1.22<sup>c</sup> | 24.41±0.74<sup>a</sup> | 25.75±0.69<sup>b</sup> | 25.39±0.79<sup>b</sup> |                   |

Note: Different superscripts in the same row or column showed a very noticeable difference (P˂0.01)

Meat cooking loss showed a decrease in chicken meat that had been marinated using *Garcinia atroviridis* extract. Meat marinated using *Garcinia atroviridis* 3% already gave the difference in the percentage of meat cooking loss to control. It was suspected that the acid can sustain the meat to lose its moisture content and the acid contained in *Garcinia atroviridis* extract 3% has not had the effect of denaturation of meat proteins. However, the higher the percentage of *Garcinia atroviridis* extract the more cooking loss increases. This meant that an increase in the percentage of *Garcinia atroviridis* extract made acidic substances will make the meat loss further so that the moisture content of the meat will increase. The acidic substance *Garcinia atroviridis* will enter the meat so that there was a denaturation of protein so that the water content in the meat also came out.

Statistical analysis showed that the shelf life of chicken meat marinated using *Garcinia atroviridis* extract showed a noticeable difference in cooking loss (P˂0.05). The average cooking loss at 24 hours and 48 hours was 26.10% to 26.43% respectively. Meat with a shelf life of 48 hours was higher than at 24 hours. It was thought the composition and structure of the meat have undergone changes resulting in the loss of a lot of meat liquid. Duncan's test analysis showed that there was an interaction (P˂0.01) between an increase in the percentage of *Garcinia atroviridis* extracts against the cooking loss of Culled chicken meat. The output of liquid from meat due to water content decreases because the length of storage led to the interaction between the percentage of *Garcinia atroviridis* extract and the shelf life. Overall, the percentage of cooking shrinks was within the normal range. Cooking loss in chicken meat was typically between 32.90% to 34.38% [18] The addition of 3% extract (P1) was able to last within 48 hours and was the best recommendation in this study.

3.3. Meat water content

The average water content of marinated chicken laying meat using *Garcinia atroviridis* extract 0%, 3%, 6%, and 9% was 68.11, respectively; 72.13; 75.87, and 77.27%. Statistical analysis showed that *Garcinia atroviridis* marinated chicken meat with different percentages gave a very noticeable difference to water content (P˂0.01). The data in Table 3 showed that the percentage of *Garcinia atroviridis* extract 0% or P0 differed manifestly against P1. At P0 percentage also differed very real from P2 and P3. At *Garcinia atroviridis* 3% was enough to make the meat experience an increase in water content. This was because liquid-based immersion made water enter the tissues of the meat, thus affecting the moisture content of the meat. Water content was also affected by the concentration of solvents or osmosis.
Table 3. The water content of marinated *Garcinia atroviridis* extract at different shelf times

| Storage Time | Extract *Garcinia Atroviridis* (%) | P0 (0%)     | P1 (3%)     | P2 (6%)     | P3 (9%)     | Average    |
|--------------|-----------------------------------|-------------|-------------|-------------|-------------|------------|
| T1 (24 Hour) |                                   | 70.68±4.52b | 72.28±1.49b | 76.68±1.30bc| 78.02±0.97c | 74.41±3.87b|
| T2 (48 Hour) |                                   | 65.54±0.73a | 71.98±1.23b | 75.06±1.27c | 76.52±0.60bc| 72.27±4.42c|
| Average      |                                   | 68.11±4.08a | 72.13±1.30b | 75.87±1.48c | 77.27±1.10c | 74.41±3.87b|

Note: Different superscripts in the same row or column showed a very noticeable difference (P˂0.01)

The results showed an increase in water levels in the percentage of *Garcinia atroviridis* extract. The increase in water content was thought to be due to the diffusion process of solution into marinated meat due to the influence of the solution on extracts higher than water in the meat. The data in Table 3 showed that the shelf life differed in real (P˂0.05). This meant that the longer the shelf life of the meat will decrease even if it was still within the normal range. Interactions have a very noticeable effect (P˂0.01) on moisture content. Interactions occur at *Garcinia atroviridis* extract percentages of 0%, 3%, 6%, and 9% with a shelf life of 24 hours and 48 hours. It was suspected that the high percentage of *Garcinia atroviridis* extract caused the higher the diffusion process of the solution into the marinated meat thus increasing the moisture content of the meat, but at a shelf life of 48 hours, the moisture content will gradually decrease due to the reduced meat liquid caused by the actin and myosin bonding together thus making the meat decrease water content. The water content in meat was generally between 65% and 80% [17]. The water content in meat in the study on marinating using *Garcinia atroviridis* extract 9% within 48 hours was still within the normal range. However, 3% of *Garcinia atroviridis* extract was recommended for use during shelf life of 24 hours or 48 hours.

3.4. Meat drip loss

The average drip loss of marinated chicken laying meat using *Garcinia atroviridis* extract 0%, 3%, 6%, and 9% was 4.06, respectively; 3.58; 4.27, and 4.41%. Data in Table 4 showed that the marination using *Garcinia atroviridis* P0 extract was no real difference (P-0.05) to P1, P2, and P3 at both 24-hour and 48-hour shelf life. But the statistical analysis also showed that *Garcinia atroviridis* marinated chicken meat made a noticeable difference to the average drip loss (P˂0.05) at a shelf life of 24 hours and 48 hours. Based on the tests that have been done marinating using *Garcinia atroviridis* did not have a significant effect but the longer the shelf life will occur the increase in the value of drip loss. Drip loss was a droplet of water that comes out when the meat is hung or during meat storage [18,19]. Drip or water droplets usually contain meat nutrients so the greater the value of drip loss eating the lower the quality of meat. Drip loss was related to the bonding of water in the meat. If the water supply was high then the drip loss percentage will below, and vice versa if the water supply was low then the drip loss percentage will be high.

Table 4. Drip loss of marinated *Garcinia atroviridis* extract at the different shelf life

| Storage Time | Extract *Garcinia atroviridis* (%) | P0 (0%)     | P1 (3%)     | P2 (6%)     | P3 (9%)     | Average    |
|--------------|-----------------------------------|-------------|-------------|-------------|-------------|------------|
| T1 (24 Hour) |                                   | 4.00±0.59   | 3.76±0.32   | 4.11±0.48   | 4.18±0.52   | 3.95 ± 0.51|
| T2 (48 Hour) |                                   | 4.13±0.59   | 3.88±0.50   | 4.23±0.55   | 4.30±0.50   | 4.20 ± 0.60|
| Average      |                                   | 4.06 ± 0.58b| 3.58 ± 0.32a| 4.27 ± 0.48b| 4.41 ±0.52a | 4.20 ± 0.60|

Note: Different superscripts in the same row or column showed a very noticeable difference (P˂0.01)

Drip loss on meat between 4.04 to 6.46% [20]. The percentage of drip loss in broiler chicken breast meat between 11.47% to 12.29% [21]. The drip loss in this study was in line with [22] that drip loss in
marinated meat was between 3.34% to 5.58%. This meant the drip loss in this study was still within the normal range. The acid in spices usually does have a physical effect on the quality of the meat [23].

4. Conclusions
The higher garcinia atroviridis extract for marination will lead to decreased pH value, lower cooking loss value and increase meat moisture content. The increase in *Garcinia atroviridis* extract also does not affect drip loss but in relation to shelf life it can increase drip loss. The results also showed the physical quality of the chicken meat was still in the normal range and better than the controls. The use of garcinia atroviridis extract 3% is recommended to improve the physical quality of culled chicken meat at a shelf life of 24 to 48 hours.

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