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Effect of Gelugur (*Garcinia atroviridis*) Acid Juices on pH and Organoleptic Test of Quail (*Coturnix coturnix japonica)* Meat

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ABSTRACT

Quail meat (*Coturnix coturnix japonica*) has high protein content, as well as low fat. This research aims to determine the effect of using gelugur tamarind juice on the physical quality and organoleptic quality of quail meat. The research was conducted in June-July 2024 at the Technology Research Laboratory, Faculty of agriculture and Animal Production Laboratory, Faculty of Agriculture, Universitas Sumatera Utara. The design used in this research was a Completely Randomized Design (*CRD*) with 4 treatments and 5 replications, so in total there wewe 20 experimental units, namely T0=0ml, T1=30ml, T2=60ml and T3=90ml. The parameters used in this research are physical and quality tests, namely pH on quail meat, and organoleptic tests of color, aroma, taste and texture.The results of this study showed that administration of gelugur acid juice 30ml, 60ml, 90ml had a very significant effect (P<0,01) on physical quality and organoleptic quality. The higher the percentage of gelugur acid assence used in quail meat, the greater the physical quality and organoleptic quality of the quail meat.

Keyword: Gelugur Acid Extract, Organoleptic, Physical, Quality test,, Quail Meat.

1. Introduction

Quail (*Coturnix coturnix japonica*) is one type of poultry livestock that has considerable potential as a producer of meat and eggs because of its faster maintenance, easy handling, does not require extensive land and relatively small capital. Quails are underpopulated livestock in Indonesia. Based on data from the Food Security and Livestock Service Office of North Sumatra Province, the quail population in 2018 amounted to 219,136 heads, then in 2019 it increased to 223,978 heads, and in 2020 it further increased to 392,336 heads. The demand for quail meat (*Coturnix coturnixjaponica)* and the opportunity for quail farming is increasing every year [1].

The advantage of quail meat (*Coturnix coturnix japonica*) is its high protein content, as well as low fat. The delicious flavor is another advantage of quail meat (*Coturnix coturnix japonica*). Quail (*Coturnix coturnix japonica*) can produce meat around 70-74% of its live weight, with the heaviest body weight percentage in the breast (41%) [2]. According to [3], quail meat (*Coturnix coturnix japonica*) contains nutrients including 72.5-75.1% water, 1.0-3.4% fat, 20-23.4% protein, and 1.2-1.6% minerals. Quails (*Coturnix coturnix japonica*) that have stopped laying eggs or whose production has begun to decline can be sold or slaughtered as meat

producers that have similar flavor and nutritional value as other poultry [4]. When quails enter the age of 14 - 18 months or at the age of 1.5 years, quails are no longer producing, then quails are said to be afkir.

According to [5] gelugur acid *(Garcinia atroviridis)* is a fruit that can be consumed and has many benefits, namely as a food flavoring by Malay people and is useful for lowering cholesterol. Organic acids added such as gelugur acid *(Garcinia atroviridis)* to meat can extend shelf life because they contain antioxidants. The acidic properties of gelugur acid fruit such as citric acid, tartaric acid and malic acid are thought to improve the physical quality of tough meat [5].

The use of gelugur acid (*Garcinia atroviridis)* for processing livestock products such as meat is less well known by the wider community as in North Sumatra, so further research is needed on the use of gelugur acid (*Garcinia atroviridis)* on the quality of tenderness and organoleptic quail meat (*Coturnix-coturnix japonica*). Organoleptic is a test that utilizes the human senses as the main tool to assess the acceptability of a product whether it is acceptable or not [6].

Based on the above background, the research to be carried out is mixing liquid from geluguric acid (*Garcinia atroviridis*) with quail meat *(Coturnix coturnix japonica*) with different treatments to determine its effect on the quality of tenderness and organoleptic quail meat *(Coturnix coturnix japonica*).

2. Materials and Methods

2.1. Place and Time

The research was conducted in the Production Laboratory and in the Research Laboratory of the Faculty of Agriculture, Universitas Sumatera Utara. This research lasted for 1 month from June to July 2024.

2.2. Materials and Equipment

The equipment used in this study were cutting knife, electric scale, 250 ml beaker glass, blender, plastic basin, plastic, container, questionnaire paper and other supporting tools. The materials used in this study were 30 cull quail, 6 kg gelugur acid *(Garcinia atroviridis)* fruit, salt, sugar, and distilled water.

2.3. Research Methods.

The experimental design used in this research was a completely randomized design (CRD) with 4 treatments and 5 replications, so there were 20 experimental units in total. Each experimental unit used quail meat (*Coturnix coturnix japonica*) weighing 20 grams with a marination time for all treatments for 30 minutes.
The treatments given were as follows:
T0 = Marination without using gelugur acid juice + 100 ml of distilled water (control)
T1 = Marination using 30 ml gelugur acid juice + 70 ml of distilled water
T2 = Marination using 60 ml gelugur juice + 40 ml of distilled water
T3 = Marination using 90 ml gelugur juice + 10 ml of distilled water

The following is a combination of treatments that was used in this study (Table 1).

Table 1. Research experimental design

Treatment (T)	Replication (R)	Combination
P0 (0 ml)	U1	P0U1
	U2	P0U2
	U3	P0U3
	U4	P0U4
	U5	P0U5
P1 (30 ml)	U1	P1U1
	U2	P1U2
	U3	P1U3
	U4	P1U4
	U5	P1U5
P2 (60 ml)	U1	P2U1
	U2	P2U2
	U3	P2U3
	U4	P2U4
	U5	P2U5
P3 (90 ml)	U1	P3U1
	U2	P3U2
	U3	P3U3
	U4	P3U4
	U5	P3U5

The repeat obtained is derived from the formula:

$T (n - 1) \geq 15$

$4 (n - 1) \geq 15$

$4n - 4 \geq 15$

$4n \geq 15 + 4$

$4n \geq 19$

$n \geq 4{,}75$

$n = 5$

The mathematical model of a complete randomized design (RAL) experiment according to is as follows:

$$\mathbf{Y_{ij} = \mu + \tau_i + \varepsilon_{ij}}$$

Note:

$\mathbf{Y_{ij}}$ = observation value in i-th treatment and j-th replication

$\boldsymbol{\mu}$ = common center value

$\boldsymbol{\tau_i}$ = i-th treatment effect

$\boldsymbol{\varepsilon_{ij}}$ = effect of experimental error on i-th treatment and j-th replication

I = 1, 2, 3, and 4 (t)

J = 1, 2, 3, 4, and 5 (r)

2.4. Reasearch Procedure

2.4.1. Making Gelugur Acid Solution

Making gelugur acid solution can be done by peeling the fruit first, thinly slicing the fruit flesh and washing it thoroughly. Then the fruit flesh is mashed using a blender, after finishing the blender then filtered to separate from the pulp.

T0 = (Control) marination without using gelugur juice + 100 ml of distilled water
T1 = Marination using 30 ml gelugur juice + 70 ml of distilled water
T2 = Marination using 60 ml gelugur juice + 40 ml of distilled water
T3 = Marination using 90 ml gelugur juice + 10 ml of distilled water

So that the gelugur acid solution is obtained with a concentration of 30 ml, 60 ml, 90 ml. The gelugur juice marinade was then mixed with 2 grams of salt and 2 grams of sugar in each treatment. Then marinate the meat with gelugur acid juice for 30 minutes at room temperature with a temperature of 28°C-30°C [5].

2.4.2. The Marination Process

This research sample used 5 kg of quail meat samples, each sample was weighed 20 grams and then marinated with gelugur acid according to the treatment for 30 minutes. Frying was done at 85°C for 3 hours to dry the meat.

2.5. Research Parameters

2.5.1. Physical Quality Test (pH)

Measurements on the pH value are calculated using a digital pH meter measuring instrument. How to calculate the pH value of quail meat [5]:

a. Prepare a 20 gram sample of quail meat to be weighed.
b. Add distilled water according to the dose in the treatment
c. Turn on the pH meter that has been calibrated using a *buffer* solution until the display appears.
d. Insert the sensor into the marinated quail meat and wait until the number displayed on the screen stabilizes. The pH value displayed on the screen is the same as the pH value of the quail meat being tested [5].

2.5.2. Organoleptic Test

Organoleptic is a test of a food ingredient based on willingness and preference using a product. Organoleptic testing can also provide an indication of quality deterioration, spoilage and other damage to the product [7]. The organoleptic *test* uses a *scoring test* method based on 30 panelists, including color, aroma, tenderness, and texture. The questionnaire uses a hedonic scale for aroma, taste, texture and tenderness with a scale for aroma of 5 = very like, 4 = like, 3 = somewhat like, 2 = dislike and 1 = very dislike. Then the scale for color is 1 = off-white, 2 = white, 3 = pale red, 4 = pink and 5 = bright red. Texture with a scale of 5 = very smooth, 4 = smooth, 3 = slightly rough, 2 = rough and 1 = very rough. The score value in the organoleptic test, the highest is number 5 and the lowest is number 1.

a) Color

This color measurement was made to determine the effect of using gelugur acid on the organoleptic quality of quail meat. Color will be the first point that will arise and be taken into account by panelists. Color is a very early organoleptic parameter in presentation [8].

b) Texture

Texture measurements were conducted to determine the effect of gelugur acid on the organoleptic quality of quail meat. Texture and chewiness are closely related to water binding capacity [9]. The questionnaire used a

hedonic scale for aroma, taste, texture and tenderness with a scale for aroma of 5 = very like, 4 = like, 3 = somewhat like, 2 = dislike and 1 = very dislike. Then the scale for color is 1 = off-white, 2 = white, 3 = pale red, 4 = pink and 5 = bright red. Texture with a scale of 5 = very smooth, 4 = smooth, 3 = slightly rough, 2 = rough and 1 = very rough.

c) Scent

The size of the acceptance of a product by consumers is influenced by aroma which is one of the signs of organoleptic quality of the product [3]. [2] states that aroma can function as a sensory indicator of damage to a product if it emits a deviant odor that can be detected by the nose and is used to assess the delicacy of food value.

d) Taste

Taste measurements were carried out to determine the effect of the use of gelugur acid on the organoleptic quality of quail meat. One of the factors that play a crucial role in determining the final decision of the panelists to accept or reject a product is taste [10].

2.6. Data Analysis

The data obtained were then analyzed and processed using *Analysis of Variant* (ANOVA). If the results of the analysis of variance show a significant effect between treatments, it is further tested with the Duncan test

3. Results and Discussion

3.1. pH of Cull Quail Meat

The pH value is a degree that indicates the acidity of processed meat products. The pH value is one of the important determining factors to determine the physical quality value of processed products such as quail meat. Measurement of a meat pH value can be calculated using a *digital* pH *meter*.

Table 2. pH of cull quail meat using gelugur acid juice

Treatment	Replication					Averaged^{tn} ± SD
	I	II	III	IV	V	
T0	5,87	5,70	5,68	5,69	5,68	5,72^{d} ± 0,082
T1	5,05	5,03	5,11	5,14	5,10	5,09^{c} ± 0,045
T2	4,93	5,00	4,84	4,80	4,86	4,89^{b} ± 0,079
T3	4,58	4,31	4,53	4,60	4,57	4,52^{a} ± 0,119

Description: Different superscripts indicate significant differences between treatments (P<0.05).

From the table above, it can be seen that the highest mean pH value is found in T0, which is 5.72, while the lowest mean pH value is found in T3, which is 4.52. The results of ANOVA analysis of variance showed that the use of glugur acid as a quail meat marinade material had a very significant effect ($P < 0.01$) on the pH value of the meat. Because the results of the analysis of variance showed a very significant effect, further tests were conducted using the *Duncan Multiple Range Test* (DMRT). Based on the results of Duncan's further test, the results showed that there was a very significant effect ($P < 0.01$) between treatments.

Furthermore, DMRT (*Duncan Multiple Range Test*) was conducted on four treatments with quail meat in the addition of marinated gelugur acid juice. From these results, it can be identified that the T3 treatment (90 ml) increased the pH value of the quail meat. Gelugur acid soaking contains organic acids that cause the pH of quail meat to decrease. According to [11], the addition of acid in a food product can reduce the pH value of the product material. According to research by [12], gelugur acid soaking can reduce the pH value and inhibit the growth of microorganisms in meat.

3.2. Organoleptic Test

3.2.1. Color

How to test the color of quail meat, take enough samples and place them on a clean and dry container, then look at them to determine the color of the quail meat [13]. This color will be the first impression displayed and will be assessed by panelists.

Table 3. Quail meat color due to application of gelugur acid juice

Treatment	Replication					Averaged^{tn} ± SD
	I	II	III	IV	V	
T0	3,5	3,5	3,6	3,5	3,7	3,56^{a} ± 0,089
T1	4,0	4,6	4,4	4,7	4,8	4,08^{b} ± 0,083
T2	4,6	4,7	4,9	4,8	4,7	4,58^{c} ± 0,083
T3	4,9	4,8	4,8	4,8	4,9	4,84^{d} ± 0,054

Description: Different superscripts indicate significant differences between treatments (P<0.05).

Based on the results of *Kruskal Wallis* analysis, the results were significantly different (P<0.01) on the quail meat color test parameters. It can be seen in the table above that the average value of the highest meat color is T3, which is 4.84 (light brownish) and the lowest meat color value is T0, which is 3.56 (brownish slightly blackish). Because the results of the analysis were significantly different, further tests were carried out. Based on the results of the *Man-Whitney* further test, it was found that each treatment had a very significant difference from the other treatments.

Based on the Table 3, the T3 treatment namely the addition of 90 ml gelugur acid juice to the color of quail meat, tends to be preferred by panelists with the highest average score of 4.84. The average panelist preference for quail meat color with a score criterion of 5 (light brownish) and the lowest score of 3 (black on the surface). This finding is in line with the opinion of [14] which states that quail meat has a color that is light light brown, slightly reddish, light brown slightly whitish and grayish. According to [15], the typical color of normal processed quail meat is slightly whitish light brown.

Furthermore, when conducting the *Man-Whitney* further test, it is known that there is an interaction between the addition of gelugur juice at different concentrations which has an influence on the color of quail meat. Marination with different concentrations of gelugur juice showed that T0 was significantly different from the other treatments and T1 was significantly different from T2. From these results, it can be identified that the higher the treatment of gelugur acid added in the marination process, the more the color of the quail meat increased. In line with [16] stated that tannin compounds present in gelugur acid juice can create a light brown color in quail meat, so the higher the addition of gelugur acid juice containing tannin compounds used will further increase the light brown color of quail meat.

Based on the results of the research, the combination of treatments with the addition of gelugur juice with distilled water in the marination process on the color of quail meat is best in the T3 treatment with a score of 4.84.

3.2.2. Scent

Scent is one of the many forms of parameters in organoleptic quality to determine the acceptance of a preparation, where aroma can be used as an indicator of product damage [17].

Table 4. Scent of cull quail meat using gelugur acid juice

Treatment	Replication					Averaged^{tn} ± SD
	I	II	III	IV	V	
T0	3,7	3,7	3,5	3,5	3,8	3,64^{a} ± 0,134
T1	4,0	4,1	3,9	4,2	4,0	4,04^{bc} ± 0,114
T2	4,0	4,3	3,9	4,2	4,1	4,08^{c}± 0,158
T3	4,9	4,7	4,7	4,8	4,9	4,80^{d} ± 0,100

Description: Different superscripts indicate significant differences between treatments (P<0.05).

Based on the results of *Kruskal Wallis* analysis, the results were significantly different (P<0.01) to the test parameters of quail meat aroma. It can be seen in the table above that the average value of the highest quail meat aroma is found in T3, namely 4.80 (not fishy, smells typical of quail meat) and the lowest quail meat aroma value is found in T0, namely 3.64 (not fishy, specific quail meat is slightly reduced). Because the results of the analysis were significantly different, further tests were conducted using the *Man-Whitney* test. Based on the results of the *Man-Whitney* test, it was found that T0 was significantly different from the other treatments, T1 was significantly different from T3, and T2 was significantly different from T3.

The table above shows that the highest average aroma of quail meat organoleptic test is with treatment T3 (90 ml) on the aroma of quail meat, which tends to be more favored by panelists with the highest average score of 4.80. The average favorability of quail meat aroma panelists with score criteria 5 (not fishy, smells typical of quail meat) and the lowest at score 3 (somewhat fishy). The aroma produced in the oven-baked quail meat was obtained from the addition of gelugur juice and spices. Meanwhile, the difference in aroma produced is influenced by the amount of gelugur acid juice in the marination process used in quail meat curing, which will make the aroma less fishy. The aroma of processed products is the interaction that arises from the ingredients and is distinguished by the sense of smell. In line with the statement by [18] that the addition of spices with the marination process and the length of time in marination affects the aroma of oven-baked quail meat. In addition [17] mention that that the provision of spices and the oven process affect the aroma of quail meat, the oven process is what causes the aroma of the seasoning given to evaporate.

Furthermore, when conducting the Man-Whiteney further test, it is known that there is an interaction between the addition of gelugur tamarind juice at concentrations that have an influence on the aroma of cooked quail meat. Marination with different concentrations of gelugur juice showed that T0 was significantly different from the other treatments, T1 was significantly different from T3 and T2 was significantly different from T3. These results identified that the more gelugur acid juice added in the marination process, the more it increased the dominant sour aroma and distinctive smell of quail meat and eliminated the fishy odor of the quail meat. In line with [5] who said that the active substance content of gelugur acid juice can eliminate the fishy aroma of processed meat products.

Based on the results of the research, the combination of treatments with the addition of gelugur acid juice with distilled water in the marination process on the aroma of quail meat is best in the T3 treatment with a score of 4.80.

3.3.3. Taste

Taste is a factor that influences acceptance and determines consumer acceptance of a preparation [8].

Table 5. Flavor of afkir quail meat using gelugur acid juice

Treatment	Replication					Averaged ± SD
	I	II	III	IV	V	
T0	4,4	4,2	4,5	4,4	4,3	$4,36^{a} \pm 0,114$
T1	4,7	4,8	4,7	4,5	4,5	$4,64^{b} \pm 0,134$
T2	4,4	4,7	4,5	4,3	4,4	$4,46^{ab} \pm 0,151$
T3	3,5	3,4	3,6	3,5	3,6	$3,52^{c} \pm 0,083$

Description: Different superscripts indicate significant differences between treatments ($P<0.05$).

Based on the results of *Kruskal Wallis* analysis, the results were significantly different ($P<0.01$) on the quail meat flavor test parameters. It can be seen in the table above that the average value of quail meat flavor is highest in T1 which is 4.64 (good, dominant meat flavor) and the lowest quail meat flavor value is in T3 which is 3.52 (less good). Since the results of *Kruskal Wallis* analysis showed significantly different results, further tests were conducted. Based on the results of the *Man-Whitney* further test, it was found that T0 was significantly different from T1 and T3, and T1 proved to be significantly different from T3.

Based on the table above, it shows that the highest average taste of quail meat organoleptic test is with the T1 treatment (30 ml) on the taste of quail meat, which tends to be preferred by panelists with the highest average score of 4.64. The average liking of quail meat flavor panelists with a score criterion of 5 (good quail meat flavor is dominant) and the lowest at score 2 (not good, no quail flavor). The flavor produced in the oven-baked quail meat was obtained from the addition of gelugur acid juice and seasonings. Meanwhile, the difference in taste produced is influenced by the amount of gelugur juice and spices included in the marination process used in quail meat curing, which will make the quail meat taste dominant. In agreement with [17], it is stated that the flavor of the meat, the ingredients added, and the effect of the oven on the processed product are factors that affect the flavor of the quail meat in the oven.

Oven-roasted quail meat with the addition of spices and gelugur acid juice plays a role in improving aroma flavor, improving physical properties and being a preservative in the product. The flavor in each treatment was due to the design of the spices added. Marinating meat with the addition of spices and gelugur acid can strengthen the flavor, soften and encourage consumer acceptance of processed products [18].

Furthermore, when conducting the Man-Whiteney further test, it is known that there is an interaction between the addition of gelugur acid juice at concentrations that have an influence on the flavor of oven-baked quail meat. Marination with different concentrations of gelugur juice showed that T0 was significantly different from T1 and T3, and T1 was significantly different from T3. These results identify that the more gelugur acid juice added in the marination process, the lower the flavor of the oven-baked quail meat because the higher the gelugur acid used, the higher the pH of the meat and the acidic flavor will be dominant.

In line with [18] which states that the higher the percentage of acid and the longer the time in marination can cause a more pronounced sour taste in the processed product which creates a sour taste, seasoning taste, and meat taste perceived by the panelist, the assessment given by the panelist for a variety of flavors is anticipated as a result of different tastes and sensitivity of the taste buds. The addition of gelugur acid juice because it contains tartaric acid, malic acid, citric acid, succinic acid, and acetic acid, the addition of acid can give a sour taste to a processed product.

Based on the results of the research, the combination of treatments with the addition of gelugur acid juice with distilled water in the marination process on the taste of quail meat is best in the T1 treatment with a score of 4.64.

3.3.4. Texture

Texture is an important factor in consumer acceptance and impression. Texture is part of a texture shaper that has been considered by the public to assess the level of liking and acceptance of meat and other preparations.

Table 6. Texture of cull quail meat using gelugur acid juice

Treatment	Replication					Averaged ± SD
	I	II	III	IV	V	
T0	2,9	2,8	2,7	2,9	2,8	$2,82^{a} \pm 0,083$
T1	4,4	4,2	4,4	4,6	4,5	$4,42^{b} \pm 0,148$
T2	4,6	4,7	4,8	4,7	4,6	$4,68^{c} \pm 0,083$
T3	4,8	4,9	4,7	4,5	4,3	$4,64^{bcd} \pm 0,240$

Description: Different superscripts indicate significant differences between treatments (P<0.05).

The results of *Kruskal Wallis* analysis showed very significantly different results (P <0.01) on the parameters of quail meat texture test. It can be seen in the table above that the highest average value of quail meat texture is found in T2, namely 4.68 (elastic and chewy) and the lowest quail meat texture value is found in T0, namely 2.82 (less elastic, somewhat mushy). Because the results of the analysis obtained showed significantly different results, further tests were carried out using the *Man-Whitney* test. Based on the results of the *Man-Whitney* test, it can be explained that T0 is significantly different from the other treatments, and T1 is proven to be significantly different from T2.

Based on the table above, T2 treatment of quail meat texture tends to be more favored by panelists with the highest average score of 4.68. The average level of panelists' liking for the texture of quail meat with a score criterion of 5 (soft) and the lowest score of 1 (very hard). The texture produced in the oven-baked quail meat was obtained from the addition of gelugur acid juice in the marination process. Meanwhile, the difference in texture produced is influenced by the amount of gelugur acid juice included in the marination process and the length of time of the marination process used in the quail meat oven, which will make the texture of the quail meat feel soft.

This research found that the factors that can affect the texture of a processed product are the processing method and physiology carried out in the product processing process. [5] also argue that the acidic properties of gelugur acid juices such as citric acid, tartaric acid, and malic acid are suspected to improve the physical quality of tough meat into soft ones. Texture was influenced by the physiology and processing methods of the products tested. [5] also argues that the roughness or smoothness of a product can be used to check many factors that can be inferred from the texture of the meat.

Furthermore, when conducting further tests by Man-Whiteney, it was known that there was an interaction between the addition of acidic juice to the concentration which had an influence on the texture of the baked quail meat. Marinating with different concentrations using gelugur acid juice obtained the result that T0 was very different from other treatments, and T1 was proven to be very different from T2. The results identify that the more gelugur acid juice is added in the marination process, the more it will be able to improve the texture of the baked quail meat because the higher the gelugur acid used, the more it increases the texture softness of the dominant quail meat.

In line with the findings of [8] argue that the content of active substances and organic acids from gelugur acid juice such as citric acid can improve the physical quality of tough processed meat products. Marinating is based on using acids, which can be used to tenderize meat because it has an impact that can reduce the amount of fiber in meat or protein [5]. [18] also argue that acid-based marination can prevent damage to a processed meat product and help the product to accumulate. Marinating meat with acid can strengthen the taste, soften the texture and encourage consumer acceptance of processed products.

Based on the results of the research on the combination of treatment with the addition of gelugur acid juice with aquadest in the marination process on the texture of quail meat, the best in the T2 treatment scored 4.68.

4. Conclusion

4.1. Conclusion

The use of the best gelugur acid juice, namely at T3 as much as 90 ml, is effective in increasing the pH and organoleptic test, namely the color and aroma of quail meat, while for the taste and texture of quail meat, the best at T2 is 60 ml of gelugur acid juice.

4.2. Suggestion

From the results of the research, the addition of 60 ml of gelugur acid juice can be applied to increase the pH and organoleptic test of afkir quail meat. It is recommended for the next researcher that further research needs to be carried out by conducting chemical tests and for the next researcher it is more recommended to reduce the ferpercentage of the administration of gelugur acid juice in the marination process due to the results of the organoleptic test of this study on the more dominant taste of acid in the P3 treatment. And it is recommended for researchers to use a combination with storage techniques at room temperature.

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