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The Use of Cassava Peel and Salt Fermentation Solution on The Shelf Life of Red Tilapia Filet at Low Temperature Storage Based on Organoleptic Characteristics

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ABSTRACT

One method to extend the shelf life of fish filet is through antibacterial preservation, which can be achieved using a cassava peel fermentation solution containing lactic acid bacteria that can combat spoilage bacteria in fish. This study investigates how cassava peel fermentation solution affects the organoleptic quality of red tilapia filet under cold storage conditions (5°-10°C). Red tilapia filet were soaked in a cassava peel fermentation solution with varying salt concentrations across four treatments: 0% (control), 2%, 3%, and 4%, with a soaking time of 30 minutes per filet according to the treatment. Observations were conducted on days 1, 4, 7, 8, 9, 10, 11, and 12, with organoleptic evaluations (appearance, aroma, slime, and texture) and data analysis using the Friedman statistical test, Multiple Comparison, and Bayes test. Results indicated that a 3% salt concentration yielded the best organoleptic value, especially on day 10, with aroma as the highest-ranked parameter according to the Bayes test (weight 0,44), followed by appearance (0,37), slime (0,10), and texture (0,08). Thus, cassava peel fermentation solution with a 3% salt concentration effectively extends the shelf life of red tilapia filet.

INTRODUCTION

Fishery production, especially tilapia, continues to increase every year. Based on KKP data (2019), tilapia production in 2018 reached 1,169,144.54 tons. This high export volume opens up opportunities for stakeholders to develop more diverse similar commodities, in order to expand and advance fish farming in Indonesia. Red tilapia has the advantage of white and thick meat, high protein, low fat, and easy to cultivate. Red tilapia is favored due to its thick, white flesh, soft yet firm texture, fresh and slightly sweet taste, and its distinctive aroma, which resembles that of red snapper. Data from Balai Karantina Ikan, Pengendalian Mutu, dan Keamanan Hasil Perikanan (BKIPM 2017) of the Ministry of Marine Affairs and

Fisheries shows that tilapia fillet exports in 2017 reached 8,649.42 tons, with the main destination countries being the United States, Japan, and Europe.This shows that the world market prospects for tilapia continue to increase significantly every year, even in continental Europe, tilapia has become a favorite in the form of filet.

The freshness of the fish or filet is a key factor in determining quality. During storage, the freshness level of tilapia decreases significantly, which directly impacts its quality and market value (Kalista et al., 2018) Factors that affect the decrease in fish freshness include changes after the death of fish, namely changes in pre rigor mortis, rigor mortis, enzyme activity (autolysis), microbial activity (bacteriology), and oxidation (Junianto, 2003).

Efforts to maintain the freshness of fish can be done by storing it at low temperatures and using preservatives that are safe for consumption. Farida et al., (2018) reported that storage at 5°C can keep fish fresh for up to 5–6 days. One way to preserve fish is to use lactic acid bacteria, which belong to the gram-positive antimicrobial group. This bacteria is found in organic matter that is high in carbohydrates, such as cassava peel fermentation solution. Turyoni (2005) research stated that the carbohydrates in the skin of fresh cassava blended by 4,55% can be used as an energy source for microorganisms in the fermentation process. Carbohydrates, especially oligosaccharides, in cassava peels function to provide nutrients for lactic acid bacteria so that they can produce energy and increase the number of these bacteria (Novitasari et al., 2019). Cassava peel with salt and aquaades added will produce a lactic acid bacteria fermentation solution. According to Ali (2014), the addition of salt in the fermentation process helps reduce the solubility of oxygen in water and inhibits the activity of proteolytic bacteria. The use of salt is intended as a selective medium for bacterial growth in the fermentation process and inhibits the growth of unwanted bacteria (Hutkins, 2006).

This study aims to determine the effect of the use of cassava peel fermentation solution and the concentration of salt used as an antibacterial ingredient and maintain the quality with the longest shelf life of red tilapia filet based on the organoleptic (scoring) of red tilapia filet stored at low temperatures.

METHOD

Time and Place

The time and place of the research will be carried out at the Laboratory of Fishery Product Processing Technology and Biotechnology, Faculty of Fisheries and Marine Sciences, Padjadjaran University in February 2024.

Tools and Materials

The tools used in this study are Cool Box, Fiber Tub, Cutting Board, Filet Knife, Plastic Basin, Digital Scale, Knife, Glass Jar, Spatula, Measuring Cup, Capitan, Strainer, pH Meter, Food Liquid Absorber, Cling Wrap, Plastic Container,

Refrigerator, Gloves, Scissors, Stationery. The research materials used were live tilapia weighing 300-500 g/head as many as 17 fish, cassava skin, salt, aquades.

Research Procedure

This study uses an experimental method with 4 soaking treatments in various salt concentrations: 0%, 2%, 3%, and 4%. The treatment involves soaking cassava peel fermentation solution with different salt concentrations for 30 minutes.

Procedure for Making Cassava Peel Fermentation Solution (Nisah et al., 2021 modified)

Cassava peel is washed and brushed with clean water, then drained and then chopped 1 mm x 5 cm. The jars are sterilized and dried with a clean cloth. NaCl salts were weighed according to the treatment: 2% (3 g), 3% (4.5 g), and 4% (6 g). 150 g of cassava peel is put in a jar, 550 ml of aquaade is added (twice the volume of cassava peel), and stirred well with NaCl salt according to the concentration. The jars are labeled, coated in brown paper before being closed, and fermented for 5 days at room temperature.

Handling of Live Tilapia (Afrianto et al., 2014)

Red tilapia from the market, packaged in plastic bags filled with oxygen and water, stored in fiber tubs. The fish are acclimatized in a fiberglass tub with an aerator for 2 days to reduce stress due to transportation. Before making the filet, the live tilapia is transferred to a plastic bucket filled with water and ice cubes at a temperature of 10°C with a ratio of 1:2 to the weight of the fish for 10 minutes to reduce stress. The fish is then deactivated by being kept in a box filled with ice cubes for 30 minutes until it dies.

Filet Making

The head of the fish was cut with a knife diagonally behind the pectoral fin on both sides. The tail was cut straight from the base. To fillet the fish's body, the cut was made from the base of the head through the bones to the tail, then the fillet was separated from the ribs. The edges of the fillet were trimmed to remove the sides of the abdomen and back.

Application of Cassava Peel Fermentation Solution on Red Tilapia Filet (Nisah et al., 2021 modified)

Red tilapia filet was soaked in a filtered cassava peel fermentation solution for 30 minutes according to the four concentrations tested. After soaking, the filet is drained and placed on mica plastic with a liquid absorbent base, then packaged with cling wrap. The packaged filet are stored in a refrigerator with a temperature of 5°-10°C.

Data Analysis Technique

Organoleptic quality assessment was carried out by 5 trained panelists using a scoring test used as a parameter to determine the quality of tilapia filet that is still suitable for consumption, by providing a certain value to the characteristics or quality of the filet. Furthermore, the data was processed and analyzed using the Friedman test, then continued with the Multiple Comparison test and the Bayes test.

RESULT AND DISCUSSION

Organoleptic assessment using a scoring test was used as a parameter to determine the quality of tilapia fillet that were still suitable for consumption by assigning specific values to the characteristics or quality of the fillet. The tilapia fillet scoring test included appearance, aroma, mucus, and texture, with a score range from 1 to 9. Based on the research of Insani et al. (2016), the minimum quality requirement for organoleptic values of fresh fish fillet at low-temperature storage was 5.

Appearance

The appearance of the surface of the filet is an important aspect, besides that appearance can provide clues about chemical and microbiological changes in a product (Soekarto, 1985 in Hidayatuloh, 2008). The results of the panelists' assessment of the appearance of red tilapia filet soaked in cassava peel fermentation solution on the 10th day are in Table 1.

Table 1. Median and Average Values of Red Tilapia Filet Appearance on Day 10 Based on the Soaking Treatment of Cassava Peel Fermentation Solution During Low Temperature Storage (5-10°C).

Concentration (%)	Median Value	Average Score
0	3	3a
2	3	3a
3	5	5a
4	3	3,8a

Description: The average value followed by the same lowercase letter towards the column shows a noticeable difference and no significant difference in results according to a multiple comparison test at a 5% confidence level.

Based on Table 1, the treatment of soaking cassava peel fermentation solution at salt concentration had no effect on the appearance value of red tilapia filet. The results of the double comparison statistical test showed that all treatments, namely 0%, 2%, 3% and 4% salt concentrations, were not significantly different. The best treatment was the addition of 3% salt concentration, with an average value of 5 based on the organoleptic assessment of appearance.

The median appearance value of the fillets without soaking treatment in cassava peel fermentation solution (0% salt concentration) reached the acceptance

limit on the 8th day. Salt concentrations of 2% and 4% reached the acceptance limit on the 9th day, while the 3% concentration reached the limit on the 10th day, as indicated by a median value of 5. At this point, the fillet began to turn pseudo-pink, slightly dull yet somewhat shiny, and the bloodstains along the lateral lines appeared brownish-red.

Changes in the texture of fish fillets occurred because hydration or water loss from the fish caused the meat texture to harden, become dull, and appear wrinkled on the surface, thereby reducing the appearance value. Cold storage conditions applied to the fish fillets could not prevent changes in appearance because cold conditions drew water out of the fillets, causing the flesh to turn pale brown, incision lines to fade, muscle tissues to weaken, and the mucus layer to become cloudy suspected to be due to psychrotrophic bacterial contamination. According to Widyasari (2006), during storage there can be changes both physically and chemically. Rachmawati et al., (2016), stated that the decrease in appearance value was due to the activity of microorganisms in breaking down proteins that convert myoglobin into metmioglobin so that the surface of the meat turned dull and unattractive. Loppies et al., (2021), added that myoglobin is the main pigment of meat so it plays a role in the color change in fish meat.

Based on the results of statistical tests, the interaction among the four treatments did not affect the appearance value. This indicated that there was no synergy between the different salt concentrations in the cassava peel fermentation solution used to produce lactic acid bacteria as a preservative and the extended storage duration. The appearance of the fish fillets, as assessed by the panelists, was not significantly influenced by this interaction.

Mucus

Mucus can be said to be one of the most important organoleptic characteristic parameters because the presence of mucus can affect changes in other characteristics. The results of the panelists assessment of red tilapia filet mucus soaked in cassava peel fermentation solution on the 10th day are in Table 2.

Table 2. Median and Average Values of Red Tilapia Filet Mucus on Day 10 Based on Soaking Treatment of Cassava Peel Fermentation Solution During Low Temperature Storage (5-10°C)

Concentration (%)	Median Value	Average Score
0	1	3a
2	5	5a
3	5	5a
4	5	5a

Description: The average value followed by the same lowercase letter towards the column shows a noticeable difference and no significant difference in results according to a multiple comparison test at a 5% confidence level.

Based on Table 2, the treatment of soaking red tilapia fillets in cassava peel fermentation solution at different salt concentrations had no significant effect on the mucus value. The results of the pairwise comparison statistical test showed that all treatments were not significantly different; however, the average value of the 0% salt concentration was lower than the other treatments, with an average score of 3. In contrast, the treatments with 2%, 3%, and 4% salt concentrations had higher average values, each scoring 5.

Based on the organoleptic assessment of appearance, the median texture value of tilapia fillets without soaking treatment in cassava peel fermentation solution with 0% salt concentration reached the acceptance limit on the 8th day. The fillets soaked in 2% and 4% salt concentrations reached the acceptance limit on the 9th day, while those soaked in 3% salt concentration reached it on the 10th day. This was indicated by a median score of 5, which reflected the beginning of quality deterioration, such as the formation of slightly thick or sticky mucus and a somewhat transparent appearance.

According to Afrianto & Liviawaty (2010), mucus that originally had a fish-specific aroma gradually turned into a foul smell. Mucus also affected the texture condition of the filet; in addition, it influenced the appearance, because over the storage period, the color of the mucus changed from clear to sticky and yellowish-white, making the appearance less attractive and causing it to look less brilliant due to the presence of mucus (Hadiwiyanto, 1993).

Aroma

The results of the panelists' assessment of the aroma of red tilapia filet soaked in cassava peel fermentation solution on the 10th day are in Table 3.

Table 3. Median and Average Aroma of Red Tilapia Filet on Day 10 Based on Soaking Treatment of Cassava Peel Fermentation Solution During Low Temperature Storage (5-10°C)

Concentration (%)	Median Value	Average Score
0	1	1,8a
2	5	5b
3	5	5b
4	5	4,2ab

Description: The average value followed by the same lowercase letter towards the column shows a noticeable difference and no significant difference in results according to a multiple comparison test at a 5% confidence level.

Based on Table 3, the treatment of soaking red tilapia fillets in cassava peel fermentation solution with varying salt concentrations had a significant effect on the aroma value. The results of the pairwise comparison statistical test showed that the treatments with 0% and 4% salt concentrations were not significantly different. Similarly, the 2% and 3% salt concentrations were also not significantly different

from each other. In addition, no significant difference was found among the 2%, 3%, and 4% salt concentrations. However, both the 2% and 3% salt concentrations were significantly different from the 0% concentration.

Based on the organoleptic assessment of appearance, the median value of tilapia fillet without soaking treatment in cassava peel fermentation solution with a 0% salt concentration indicated a shelf life of up to the 8th day. The 2% salt concentration showed an acceptance limit up to the 9th day, while the 3% and 4% salt concentrations reached the acceptance limit on the 10th day. This was indicated by a median score of 5, which reflected the beginning of quality deterioration characterized by the loss of the fresh characteristic odor, although no off-odor was yet detected.

Changes in the smell of fish fillets during storage occurred due to oxidation processes that triggered a less fresh odor, as well as microbial metabolic activity that broke down fish proteins into derivative compounds such as ammonia. The oxidation of fats in fish muscle also led to the development of rancid odors (Nurilmala, 2009). According to Dangur et al. (2020), bacterial metabolism resulted in the formation of ammonia (NH_3), which caused unpleasant odors in the meat. Furthermore, the decrease in aroma value of the fillets was also attributed to the increased growth and activity of spoilage bacteria, which led to higher levels of nitrogenous base compounds. These compounds generated volatile alkaline substances such as ammonia, trimethylamine (TMA), histamine, and others (Erawati, 2005).

The decrease in the aroma value of fish fillets was presumed to be caused by the formation of volatile compounds. These compounds were produced through the breakdown of proteins and fatty acids contained in the fish fillet. The volatile compounds were detected by olfactory receptor cells located in the human nasal cavity, resulting in what is perceived as an odor or aroma. For a substance to produce a detectable odor, it must be volatile and slightly soluble in either water or oil. The breakdown of proteins and fats occurred due to the activity of endogenous enzymes in the fish fillet, as well as enzymes secreted by bacterial contamination.

Texture

The results of the panelists' assessment of the texture of red tilapia filet soaked in cassava peel fermentation solution on the 10th day are in Table 4.

Table 4. Median and Average Values of Red Tilapia Filet Texture on Day 10 Based on Soaking Treatment of Cassava Peel Fermentation Solution During Low Temperature Storage (5-10°C)

Concentration (%)	Median Value	Average Score
0	1	1,8a
2	5	4,2ab
3	5	5b

Concentration (%)	Median Value	Average Score
4	3	3,8a

Description: The average value followed by the same lowercase letter towards the column shows a noticeable difference and no significant difference in results according to a multiple comparison test at a 5% confidence level.

Based on Table 4, the treatment of soaking red tilapia fillets in cassava peel fermentation solution at various salt concentrations had a significant effect on their texture value. The results of the double comparison statistical test indicated that treatments with 0% and 4% salt concentrations did not differ significantly; treatments with 2% and 3% salt concentrations also showed no significant difference. However, the 0%, 2%, and 4% concentrations did not differ significantly among one another, while the 0% salt concentration was significantly different from the 3% salt concentration.

According to the organoleptic assessment of texture, the median value for fillets without cassava peel fermentation treatment (0% salt) reached the acceptance limit on the 7th day. In contrast, fillets treated with 2%, 3%, and 4% salt concentrations maintained acceptable texture values up to the 10th day, with a median value of 5. This value indicated that the fillets began to exhibit slight softness and moderate chewiness. These changes were attributed to the absence of texture-preserving compounds, allowing bacteria to rapidly break down protein components in the fish meat and accelerate spoilage.

The firm and elastic texture of the fillets at the beginning of storage gradually diminished, becoming softer and less cohesive by the end of the storage period. This degradation was caused by the lack of skeletal structure to support the fillet flesh and the occurrence of muscle contraction, leading to textural changes over time (Erikson & Misimi, 2008). The acceptance limit for texture at 2%, 3%, and 4% salt concentrations lasted longer than that of the 0% concentration. This could be attributed to the ability of lactic acid bacteria (LAB) in the fermentation solution to produce bacteriocins, which can bind water within the fish muscle matrix and slow down spoilage (Erawati, 2005).

According to Suptijah et al. (2008), the spoilage process in fish leads to unstructured and soft tissue due to autolysis, which breaks down muscle components. Febriandi et al. (2015) also reported that textural degradation during storage was influenced by chemical and enzymatic reactions as well as increased water activity. Additionally, cold storage (±5°C) did not eliminate bacterial presence but only slowed their activity. Wardhani (2016) supported this by stating that low temperatures merely suppressed microbial metabolic reactions rather than killing the microbes entirely.

Bayes Test

Table 5. Weight Value of Cassava Peel and Salt Fermernation Solution Against the

Shelf Life of Red Tilapia Filet

Criterion	Weight of Criteria
Appearance	0,37
Aroma	0,44
Mucus	0,10
Texture	0,08

The results of the calculation of the parameters of appearance, aroma, texture, and mucus of red tilapia filet showed that the highest criterion weight was found in the aroma parameter, at 0.44, which meant that aroma was the most important parameter or the main consideration according to the panelists in selecting red tilapia filet products. The second most important parameter was appearance, followed by mucus and texture with criterion weights of 0,37, 0,10, and 0,08, respectively.

The taste assessment of the red tilapia filet product determined the acceptance of the product. The aroma of red tilapia filet was very important as one of the indicators of its quality. Fresh red tilapia filet typically had a light, clean, and slightly sweet aroma, characteristic of natural freshwater fish. There was no strong or pungent fishy smell. If the red tilapia filet emitted an unpleasant odor, such as a foul or strongly sour smell, it could have been a sign that the fish was no longer fresh or was of poor quality. High-quality red tilapia filet did not have a chemical aroma or odor indicating contamination.

The Bayes test assigned a weight to each quality parameter (such as aroma, texture, appearance, and mucus), quantifying the extent to which each factor contributed to the overall product quality assessment. For instance, if aroma had the highest weight (0.44), it indicated that the panelists considered aroma the most important factor in evaluating the quality of red tilapia fillet. The weight of aroma could have provided information on how long the product could be stored before its quality deteriorated significantly. If aroma was the most important indicator, products that began to emit unpleasant odors might have needed to be removed from shelves sooner than others that relied more on factors like appearance or texture. If shelf-life labeling was based on aroma (since it had the highest weight), the product's expiration date could have been determined based on how long the product retained the desired aroma.

CONCLUSION

This study shows that the use of cassava peel fermentation solution with a salt concentration of 3% is effective in maintaining the organoleptic quality of red tilapia filet at low temperature storage. The 3% salt concentration resulted in high organoleptic values in terms of aroma and texture, while the appearance and mucus were relatively stable in all treatments. Based on the Bayes test, aroma is the highest weight quality determinant parameter (0.44), indicating that aroma is the main

indicator of consumer acceptance of filet. Therefore, cassava peel fermentation solution with a salt concentration of 3% is recommended as an efficient natural preservation method to increase the shelf life of red tilapia filet under cold storage conditions.

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