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SOAKING FERMENTATION OF RICE WASHING WATER AND SALT ON THE SHELF LIFE OF RED TILA FILETS AT LOW TEMPERATURE STORAGE BASED ON ORGANOLEPTIC CHARACTERISTICS

Perendaman Fermentasi Air Cucian Beras dan Garam Terhadap Masa Simpan Filet Nila Merah pada Penyimpanan Suhu Rendah Berdasarkan Karakteristik Organoleptik

Evi Liviawaty*, Shilfana Fitriana

Fisheries Study Program, Faculty of Fisheries and Marine Science, Padjajaran University

Bandung-Sumedang Highway Km 21 Jatinangor, West Java.

*Corresponding Author: shilfanaf@gmail.com

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ABSTRACT

Red tilapia is widely favored by Indonesians due to its resemblance to red snapper in terms of texture and flavor. One of the products made from tilapia is skin-on tilapia fillets, which are known for their high nutritional content, particularly in terms of protein and fat. However, a drawback is that its quality deteriorates rapidly. One approach to minimizing bacterial growth is through the addition of natural preservatives. When salt is added to rice water and allowed to ferment, lactic acid is produced, which possesses antibacterial properties that help slow bacterial growth. This study aims to identify the optimal salt concentration in fermented rice water for extending the shelf life of red tilapia fillets, based on their organoleptic qualities under cold storage conditions (5°-10°C). An experimental method was used, involving four treatments: soaking the tilapia fillets for 30 minutes in fermented rice water with varying salt concentrations (0%, 2%, 3%, 4%) over a 12-day period, with evaluations by five trained panelists. The findings indicated that immersion in fermented rice water influenced the shelf life of red tilapia fillets, as assessed through organoleptic criteria. The fermented solution maintained the aroma, texture, and slime quality until day 9, and preserved the visual appearance until day 10. From these results, it can be concluded that using fermented rice water with a 3% salt concentration is the most effective in preserving the freshness of red tilapia fillets under low-temperature storage (5°C-10°C).

Keywords: Fermented Rice Washing Water, Low Temperature, Organoleptic, Red Tilapia Fillet

ABSTRAK

Ikan nila merah sangat disukai oleh kebanyakan masyarakat Indonesia karena daging pada ikan tersebut yang mirip dengan ikan kakap merah. Salah satu produk olahan yang dihasilkan dari ikan nila adalah fillet ikan nila dengan kulit, yang memiliki keuntungan dalam hal

kandungan gizi, terutama protein dan lemak. Meskipun demikian, produk ini memiliki kekurangan karena kualitasnya cenderung menurun dengan cepat. Untuk mengahdapi dan menyelesaikan masalah ini, salah satu metode yang dapat dilakukan adalah menambahkan bahan pengawet alami untuk mengurangi jumlah bakteri. Garam dalam kadar tertentu dicampurkan ke dalam air cucian beras yang kemudian difermentasi untuk menghasilkan asam laktat yang memiliki sifat antibakteri, sehingga dapat memperlambat pertumbuhan bakteri. Penelitian ini mempunyai tujuan untuk menemukan konsentrasi garam paling efektif yang ada pada fermentasi air cucian beras untuk memperpanjang umur simpan fillet ikan nila merah, dengan mengamati karakteristik organoleptik selama penyimpanan pada suhu rendah (5°-10℃). Ada empat pelakuan pada ekspremintal yang digunakan dalam metode penelitian ini, yaitu terdiri dari merendam fillet ikan nila selama 30 menit dalam fermentasi air cucian beras dengan konsentrasi garam 0%, 2%, 3%, dan 4% selama 12 hari, melibatkan 5 panelis terlatih sebagai pengulangan. Hasil penelitian menunjukkan bahwa perendaman dalam fermentasi air cucian beras dapat mempengaruhi umur simpan fillet ikan nila merah berdasarkan karakteristik organoleptiknya. Fermentasi air cucian beras mampu menjaga skor aroma, tekstur, dan lendir hingga hari ke-9, serta mempertahankan skor penampilan sampai hari ke-10. Berdasarkan temuan ini, dapat disimpulkan bahwa penggunaan fermentasi air cucian beras dengan mempunyai konsentrasi garam 3% adalah perlakuan paling efektif dalam menjaga kesegaran fillet ikan nila merah, berdasarkan evaluasi organoleptik sepanjang masa penyimpanan pada suhu rendah (5°-10℃).

Kata Kunci: Fermentasi Air Cucian Beras, Filet Nila Merah, Organolpetik, Suhu Rendah

INTRODUCTION

Red tilapia is very well known and widely consumed by the Indonesian people, mainly due to high market demand. Its white meat and taste similar to freshwater fish make it delicious and rich in flavor, and has a high nutritional content, especially low in protein and fat (Amir *et al.,* 2014). In addition, tilapia has few bones, making it easy to process into various processed products (Riyadi *et al*., 2019). Interesting product innovation is very important to provide variety and convenience for consumers in consuming fish. The increasingly popular fish processing process in the community produces fish fillet products. Fillets offer a number of advantages, such as ease of processing into derivative products or other processed products, displayed with an attractive presentation, and easy distribution and transportation (Afrianto & Liviawaty, 1998).

However, the problem of high bacterial contamination in tilapia fillets must be taken seriously, and a strategy is needed to control this contamination during the processing process. Fish storage is a crucial step in the food supply chain to ensure the freshness and quality of fish before it reaches consumers. One method that is commonly or often used to extend the shelf life of fish fillets is to store them at low temperatures. However, fish can still be damaged or lose quality at low temperatures if not properly processed beforehand. Especially for red tilapia fillets, storage at low temperatures can be a challenge because of their sensitivity to environmental changes.

Lactic acid bacteria have a unique ability to prevent fish spoilage, because they can kill bacteria that cause spoilage that come from the fermentation process with vegetables and fruits (Siagian, 2013). Carbohydrates function as a substrate for the growth of lactic acid bacteria. Rice itself contains 85% carbohydrates, 8% protein, and 80% vitamin B1 (Haryadi, 2006). Research shows that fermentation of rice washing water, especially when combined with salt, can extend the shelf life of food, including fish products. This fermentation process can increase

the product's resistance to pathogenic and degrading microorganisms, as well as provide distinctive taste and aroma characteristics.

Seeing this potential, fermentation of rice washing water can be an alternative natural preservative for tilapia fillets, by utilizing lactic acid bacteria. To assess whether rice washing water can extend the shelf life of tilapia fillets, it is important to collect accurate information regarding the shelf life of this product. Therefore, research on the shelf life of red tilapia fillets is very necessary, focusing on organoleptic characteristics during storage at low temperatures, using the immersion method in fermented rice washing water mixed with salt. The purpose of this study was to find the most optimal salt concentration in fermented rice washing water, so that it can increase the shelf life of red tilapia fillets based on organoleptic characteristics at low storage temperatures (5°-10°C). It is expected that the results of this study can make a significant contribution to the fisheries industry and improve the quality of fish products circulating in the market.

RESEARCH METHODS

Time and Place

This research was conducted at the Laboratory of Fisheries Product Processing Technology, Faculty of Fisheries and Marine Sciences, Padjadjaran University. The research activities took place from February to March 2024, focusing on the development of innovative fisheries product processing technology to improve product quality and shelf life.

Tools and materials

The tools needed and used in this study include digital scales, glass jars, sieves, latex gloves, knives, cutting boards, plastic mica mats, refrigerators, plastic wrap, food tongs, drainers, fiberglass tubs, styrofoam boxes, cool boxes, and aerator hoses. Meanwhile, some of the materials used consist of distilled water, salt, 95% alcohol, rice, fermented rice washing water solution, red tilapia, red tilapia fillets, and ice cream. All equipment and materials are selected based on research standards to ensure optimal results and in accordance with laboratory procedures.

Research Procedure

Making Fermented Rice Washing Water

Rice was washed with clean water once with a ratio of 1:2. After that, 150 ml of rice washing water was put into a sterilized jar, then distilled water was added twice as much as the height of the rice washing water in the jar. Salt was added to the mixture, then the solution was homogenized and fermented for 6 days at room temperature. During the fermentation process, the jar was tightly closed to prevent contamination, and the mixture was stirred every day to ensure even distribution and proper fermentation.

Fillet Making Procedure

Red tilapia was cleaned by cutting the back of the head and base of the tail, then the meat was separated from the bones. After that, the resulting fillet was washed using cold water and stored in a drainer. The fillet was allowed to drain for one minute, then transferred to a clean and sterile container to avoid contamination. Furthermore, the fish fillet was ready for further processing according to the established research procedures.

Application of Rice Washing Water Fermentation on Red Tilapia Fillets

Red tilapia fillets were soaked in a fermented solution of rice washing water with the addition of salt at concentrations of 0%, 2%, 3%, and 4% for 30 minutes. After soaking, the fillets were drained and placed in a mica tray that had been lined with tissue and perforated plastic. The fillets were then wrapped in plastic wrap and stored in a refrigerator at a temperature between 5° and 10°C. Organoleptic tests were carried out for each treatment on days 1, 4, 7, 8, 9, 10, 11, and 12 to assess changes in fillet characteristics during storage.

Data Analysis

The results of the organoleptic test were analyzed using non-parametric methods, especially the Friedman test, to evaluate panelist preferences for the organoleptic characteristics of the fillets. The analysis was continued with a multiple comparison test to see the differences between treatments. The decision regarding the best treatment was determined through the Bayes test. In addition, each research result was analyzed carefully to ensure the effectiveness of using fermented rice water as a natural preservative in extending the shelf life of red tilapia fillets. The data obtained were also compared with existing quality standards to assess the superiority of the resulting product, as well as provide recommendations for further application in the fisheries processing industry.

RESULTS

Appearance

The results of the evaluation test of the appearance of red tilapia fillets soaked in fermented rice washing water with various different salt concentrations, stored at low temperatures (5°-10°C) are shown in Table 1.

Table 1. Median and Average Values Resulting from the Appearance of Red Tilapia Fillets on the 10th Day Based on the Treatment of Soaking Fermented Rice Washing Water with the Addition of Different Salt Concentrations During Low Temperature Storage (5°-10°C)

Concentration (%)	Median Value	Average value
0	3	2.6 [a]
2	3	3 [a]
3	5	5 [a]
4	3	3 [a]

Based on Table 1, red tilapia fillets treated with rice washing water fermentation soaking with different salt concentrations during low temperature storage (5°-10°C) showed that there was no significant effect between treatments. At a concentration of 3%, the highest average value was 5a, while the lowest average value was 0% concentration of 2.6a. These results indicate that although there are variations in salt concentration, its effect on the appearance of red tilapia fillets at low temperatures is not significant. This study can be a reference for the development of more effective fish processing and storage methods.

Aroma

The results of the aroma evaluation test of red tilapia fillets soaked in rice washing water fermentation with different salt concentrations, stored at low temperatures (5°-10°C) are shown in Table 2.

Table 2. Median and Average Values of Red Tilapia Fillet Aroma on Day 9 Based on Rice Washing Water Fermentation Soaking Treatment During Low Temperature Storage (5°-10°C)

Concentration (%)	Median Value	Average value
0	3	3 [a]
2	5	4.2 [a]
3	5	5.4 [b]
4	5	5 [ab]

Based on Table 2, red tilapia fillets soaked in fermented rice washing water with the addition of various salt concentrations during storage at low temperatures (5°-10°C) showed significant differences, as well as some insignificant differences. The addition of salt with concentrations of 0%, 2%, and 4% did not show any significant differences. However, there was no significant difference in the addition of salt with concentrations of 3% and 4%. On the other hand, treatments with salt concentrations of 0%, 2%, and 3% showed significant differences. The 3% salt concentration recorded the highest average value of 5.4b, while the 0% concentration recorded the lowest average value, which was 3a. This finding provides important insights into the effect of salt concentration on the quality of red tilapia fillets during storage.

Texture

The results of the texture evaluation test of red tilapia fillets soaked in fermented rice washing water with different salt concentrations, stored at low temperatures (5°-10°C) are shown in Table 3.

Table 3. Median and Average Values of Red Tilapia Fillet Texture on Day 9 Based on Rice Washing Water Fermentation Soaking Treatment During Low Temperature Storage (5°-10°C)

Concentration (%)	Median Value	Average value
0	1	1.8 [a]
2	5	4.2 [ab]
3	5	5 [b]
4	3	3 [a]

Based on Table 3, red tilapia fillets soaked in fermented rice water with the addition of various salt concentrations during storage at low temperatures (5°-10°C) showed significant differences, as well as some insignificant differences. The addition of salt with concentrations of 0%, 2%, and 4% did not show any significant differences. Likewise, in the addition of salt with concentrations of 2% and 4%, there was no significant difference. However, in the treatment of adding salt with concentrations of 0%, 3%, and 4%, significant differences were found. The salt concentration of 3% recorded the highest average value of 5b, while the concentration of 0% recorded the lowest average value, which was 1.8a. These findings provide a clearer picture of the effect of salt concentration on the quality of red tilapia fillets during the storage process, and can be an important reference for better fish processing practices.

Slime

The results of the evaluation test of the slime of red tilapia fillets soaked in fermented rice washing water with different salt concentrations, stored at low temperature (5°-10°C) are shown in Table 4.

Table 4. Median and Average Values Resulting from Red Tilapia Fillet Mucus on Day 9 Based on Rice Washing Water Fermentation Soaking Treatment During Low Temperature Storage (5°-10°C)

Concentration (%)	Median Value	Average value
0	3	2.6 [a]
2	3	3 [a]
3	5	5 [a]
4	3	3 [a]

Based on Table 4, red tilapia fillets soaked in fermented rice washing water with the addition of various salt concentrations during storage at low temperatures (5°-10°C) showed that there was no significant effect between the treatments applied. The 3% salt concentration recorded the highest average value of 5a, while the 0% concentration had the lowest average value, which was 2.6a. These results indicate that although there is a variation in salt concentration, its effect on the quality of red tilapia fillets during storage at low temperatures is not significant enough. This finding can be a consideration for the fish processing industry to better understand the effect of these treatments in improving the quality of their products.

Bayes Test

The results of the calculation analysis to determine the best treatment using the Bayes method, considering the criteria of appearance, aroma, texture, and mucus on red tilapia fillets soaked in fermented rice washing water with variations in salt concentration during storage at low temperatures (5°-10°C), can be seen in Table 5.

Table 5. Decision Matrix for Red Tilapia Fillet Assessment Based on Fermented Rice Washing Water Soaking Treatment During Storage at Low Temperature (5°-10°C).

Treatment	Criteria				Alternative Values	Priority Values
	Appearance	Aroma	Texture	Mucus		
A	3	3	1	3	2.83	0.18
B	3	5	3	3	3.88	0.25
C	5	5	3	5	4.83	0.31
D	3	5	3	3	3.88	0.25
Criteria Value	0.37	0.44	0.08	0.10	15.42	1.00

Based on Table 5, the analysis conducted using the Bayes method shows that red tilapia fillets soaked in fermented rice water with a salt concentration of 3% are the most preferred treatment by panelists based on the results of the organoleptic test. This treatment obtained the highest alternative value of 4.83 and the highest priority value of 0.31. On the other hand, the treatment without adding salt (0%) was the least preferred choice, with the lowest alternative value and priority value of 2.83 and 0.18, respectively. These findings indicate that the addition

of salt during the soaking process can significantly increase consumer acceptance of red tilapia fillets. This can be a valuable guide for manufacturers in developing more attractive and high-quality products.

DISCUSSION

Appearance

Consumers usually judge a product based on its appearance first. Shape and color are factors that influence visual assessment, with products that have attractive colors and perfect appearance tend to be preferred. All treatments of the appearance of red tilapia fillets experienced a decrease in median values during storage at low temperatures. The treatment of soaking in fermented rice water without salt (0%) showed the fastest decrease in appearance value, followed by salt concentrations of 4%, 2%, and the slowest was 3%.

On the first day of storage, all treatments had the same median appearance value, which was 9. This value is the highest, indicating that the red tilapia fillets were initially white with a shiny pink "opaque" appearance and bright red side lines. The acceptance limit for tilapia fillets soaked in fermented rice water with salt was determined based on appearance, where treatments with salt concentrations of 0%, 2%, and 4% had a shelf life of 9 days, with an average value of 5. This indicates that the fillets have a white meat color with a slight dullness and a side line that turns reddish brown. On the other hand, treatment with a salt concentration of 3% remained acceptable until the 10^{th} day.

The addition of salt with a concentration of 3% proved to be the most effective in maintaining the appearance of red tilapia fillets, because it was able to maintain visual quality until the 10th day. Soaking in fermented rice water containing salt throughout storage at low temperatures (5°-10°C) proved to be effective in extending the shelf life of red tilapia fillets, thanks to the presence of antibacterial compounds produced during fermentation, which can inhibit bacterial growth. The process of binding meat tissue with the solution also contributed to changes in meat color. Over time, the freshness of red tilapia fillets decreased, and visual changes showed signs of decay such as significant color changes. Thus, the method of fermentation of rice washing water by adding salt is not only able to maintain visual quality, but also helps extend the shelf life of red tilapia fillet products.

Aroma

Aroma plays an important role in the food industry as a flavoring element that increases consumer appeal to food (Antara & Wartini, 2014). All treatments in this study showed a decrease in the median value of the aroma of red tilapia fillets during storage at low temperatures. On the first day of storage, each treatment had the same median aroma value, which was 9, indicating that the red tilapia fillets had a fresh aroma with a distinctive fish odor. Treatment without adding salt (0%) was able to maintain the aroma until the 8th day with a median value of 5, indicating that the fillets still had a slightly fresh aroma even though the distinctive fish odor began to fade.

Fillets that were not given salt (0%) experienced aroma decay faster due to the absence of inhibitors that could suppress the growth of spoilage bacteria. On the other hand, the addition of salt at concentrations of 2%, 3%, and 4% managed to maintain the fresh aroma of the fillets until the 9th day. The addition of salt has an effect on total lactic acid, the number of bacteria, water content, sensory value, and consumer acceptance levels (Anggraeni, 2021). Salt with a concentration below 2.5% is known to trigger the growth of bacteria that cause rot and proteolytic bacteria that inhibit fermentation in food ingredients, while salt with a concentration above. 10% can interfere with the fermentation process (Azka *et al*., 2018).

The change in aroma in fish fillets is caused by the activity of bacteria that break down protein and fat (Insani *et al*., 2016). The process of protein and fat degradation by microbes produces a foul odor due to the growth of putrefying microorganisms (Buckle *et al*., 1987). Compounds such as carboxylic acid and sulfide acid are produced through the process of protein breakdown by proteolytic enzymes (Dwetro *et al*., 2017). Over time, the aroma quality of red tilapia fillets continues to decline because the distinctive fish odor begins to change into an unpleasant odor, which is caused by fat oxidation and protein degradation due to microbial activity (Winarno, 1997). The longer the storage duration, the greater the risk of decreasing the aroma quality of the fillets. Therefore, the use of natural preservatives such as salt and fermented rice water is very important to maintain the aroma and freshness of fish products.

Texture

One of the most important factors in determining food quality is texture. The texture of red tilapia fillets was assessed organoleptically by pressing the fillets using the hand. On the 8th day, the fillets with 0% salt addition treatment were no longer acceptable based on the median texture value of 5, indicating that the fillets became soft and lost their elasticity. According to research by Insani (2016), the minimum organoleptic value accepted for fresh fish fillets stored at low temperatures is 5. Salt concentrations of 2%, 3%, and 4% managed to maintain texture until the 9th day. This decrease in quality occurs due to microbial activity and enzymatic processes that break down proteins in meat, resulting in changes such as color, texture, and the appearance of ammonia odor during storage (Suwandi, 2015). According to Ramadhani (2021), the process of decomposing fish body tissue that causes the meat to become soft is caused by enzymatic action and bacterial growth. Changes in the structure of red tilapia fillets occur due to damage to the components of the connective tissue of the meat due to autolysis and microbial activity, so that the meat tissue loses its strength. After the fish dies, the enzymatic process of tissue decomposition continues automatically due to complex mechanisms (Moeljanto, 1992). Damage to meat components, especially protein, is closely related to water content, which causes loss of water bonds and makes the meat lose its elasticity so that its texture becomes soft (Hadiwiyoto, 1993).

Slime

The appearance of mucus on red tilapia fillets during storage is a sign of a decrease in quality. The mucus that appears on the surface of the fish is an important indicator of the level of freshness of the fish, which can be evaluated based on the shine and thickness of the mucus layer (Bakkara, 2013). Red tilapia fillets without added salt (0%) experienced the fastest decline in mucus quality, followed by treatments with salt concentrations of 4%, 2%, and finally 3%. On the first day of storage, all treatments had the same median mucus value, which was 9, which was the highest value, indicating that the fillets were still fresh without mucus, with clear and homogeneous fluid.

The acceptance limit of red tilapia fillets soaked in fermented rice washing water with the addition of salt concentrations of 0%, 2%, and 4% was recorded until the 8th day, with a median value of 5. This indicates that the fillets have a thin, slightly thick or sticky, and somewhat transparent layer of mucus. On the other hand, treatment with a salt concentration of 3% proved to be the most effective because it was able to maintain the appearance of the fillets until the 9th day. In the hyperaemia phase of the decay process, the mucus formed comes from the fish glands which release fluid, forming a thick layer on the surface. In addition, higher ambient temperatures accelerate the growth rate of bacteria, which causes the mucus layer to thicken (Sunarman, 2000). Damage to fish protein is also a cause of mucus formation, because the protein undergoes enzymatic degradation so that it loses its ability to bind water (Junianto

& Fitriana, 2024). In long-term storage, maintaining mucus levels is an important challenge to maintain fillet quality. Treatment with fermented rice washing water and the right salt concentration not only helps inhibit excessive mucus formation, but also slows down the decay process significantly.

Bayes test

Based on calculations using the Bayes method, red tilapia fillets soaked in rice washing water with the addition of 3% salt concentration were the most preferred treatment by panelists. This was based on the results of the organoleptic test which showed that the fillets had the highest alternative and priority values, which were 4.83 and 0.31, respectively. Treatments with salt concentrations of 2% and 4% followed with alternative and priority values of 3.88 and 0.25. Meanwhile, the treatment without the addition of salt (0%) was the least preferred treatment, with the lowest alternative and priority values of 2.83 and 0.18.

From the criteria assessed, namely appearance, aroma, texture, and mucus, it can be concluded that variations in salt concentration significantly affected panelists' perceptions of red tilapia fillets. The use of salt has been shown to improve fillet quality, both in terms of appearance and shelf life. Based on Bayesian analysis, preference for the treatment with a salt concentration of 3% showed a consistent increase. The addition of salt is not only able to suppress excessive mucus production, but also helps maintain the texture of the fillet, the distinctive aroma of the fish, and the appearance that is still preferred by the panelists. Furthermore, tilapia fillets soaked in fermented rice washing water with various salt concentrations showed a pattern of bacterial growth that tended to be stable in each treatment. Salt plays an important role in controlling the environment during the fermentation process, which can ultimately suppress the development of spoilage bacteria by regulating the growth of lactic acid bacteria (Fitriana et al., 2024). Thus, the use of fermented rice washing water combined with the addition of salt is an effective method in extending the shelf life of red tilapia fillets.

CONCLUSION

Based on the results of the research that has been done, it can be concluded that the treatment using fermented rice washing water with a salt concentration of 3% is the most effective method to maintain the freshness of red tilapia fillets. This conclusion is based on the evaluation of organoleptic characteristics during storage at low temperatures (5°-10°C). The soaking process in fermented rice washing water showed a significant impact on extending the shelf life of red tilapia fillets, as seen from the increase in the quality of organoleptic characteristics.

In addition, fermented rice washing water was effective in maintaining the quality of the fillets, including aroma, texture, and mucus, which could last up to the 9th day. The appearance of the fillets was also well maintained until the 10th day, indicating that this method not only extends the shelf life but also maintains the visual appeal of the product. This shows that the addition of 3% salt in fermented rice washing water can inhibit the growth of spoilage bacteria and maintain the organoleptic quality of the fillets. Therefore, this method can be used as a very effective solution to increase the shelf life and maintain the quality of red tilapia fillets, while providing additional benefits in the food industry by extending the consumption period of the product and maintaining its nutritional value and visuals. The utilization of fermented rice washing water can be optimized in the fish processing process to meet market needs that want high-quality and long-lasting products.

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