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THE EFFECT OF FERMENTED RICE WASHING WATER AND VINEGAR SOAKING ON THE SHELF LIFE OF RED TILAPIA FILLETS DURING LOW-TEMPERATURE STORAGE BASED ON ORGANOLEPTIC CHARACTERISTICS

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

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ABSTRACT

Red Nile tilapia (Oreochromis niloticus) fillet is a highly nutritious aquaculture product but is prone to spoilage, thus requiring environmentally friendly preservation innovations. This study aimed to evaluate the effect of fermented rice washing water with varying vinegar concentrations on the organoleptic characteristics of red tilapia fillets during cold storage. The research was conducted experimentally at the Laboratory of Fishery Product Technology, Universitas Padjadjaran, using five vinegar concentration treatments (0%, 0.5%, 1%, 1.5%, and 2%), and organoleptic parameters observed included appearance, odor, mucus, and texture. Data were analyzed using the Friedman test and Bayesian analysis. The results showed that the treatments significantly affected fillet shelf life, particularly in maintaining appearance and mucus up to day 11 of storage. The 1% vinegar concentration was identified as the most effective treatment in preserving fillet freshness during refrigeration. In general, the combination of fermented rice washing water and vinegar can serve as a natural preservative alternative to extend the shelf life of fishery products.

Keywords: Cold Storage, Organoleptic Characteristics, Red Tilapia Fillet, Rice Washing Water Fermentation, Vinegar

ABSTRAK

Fillet ikan nila merah (*Oreochromis niloticus*) merupakan produk perikanan bernilai gizi tinggi namun mudah rusak, sehingga diperlukan inovasi pengawetan ramah lingkungan. Penelitian ini bertujuan mengkaji pengaruh larutan fermentasi air cucian beras dengan variasi konsentrasi cuka terhadap karakteristik organoleptik fillet nila merah selama penyimpanan suhu rendah. Penelitian dilakukan secara eksperimental di Laboratorium Teknologi Hasil Perikanan, Universitas Padjadjaran, dengan lima perlakuan konsentrasi cuka (0%, 0,5%, 1%, 1,5%, dan 2%) dan pengamatan parameter organoleptik (kenampakan, aroma, lendir, dan tekstur). Data dianalisis menggunakan uji Friedman dan uji Bayes. Hasil menunjukkan bahwa perlakuan

berpengaruh nyata terhadap daya simpan fillet, khususnya dalam mempertahankan kenampakan dan lendir hingga hari ke-11 penyimpanan. Konsentrasi cuka 1% merupakan perlakuan terbaik dalam menjaga kualitas fillet selama penyimpanan dingin. Secara umum, kombinasi fermentasi air cucian beras dan cuka dapat digunakan sebagai alternatif pengawet alami untuk memperpanjang masa simpan produk ikan.

Kata Kunci: Fermentasi Air Cucian Beras, Cuka, Filet Nila Merah, Penyimpanan Dingin, Karakteristik Organoleptik

INTRODUCTION

Red tilapia (*Oreochromis niloticus*) is one of the types of farmed fish that is in great demand by the Indonesian people, due to its advantages in rapid growth, bright meat color, and preferred taste (Fauziah et al., 2018). Tilapia production in Indonesia reached 1.35 million tons in 2021 (KKP, 2022), making it one of the types of fish for consumption that has great potential for further processing. Red tilapia fillet is one of the most popular processed products, in the form of pieces of fish meat that have been separated from the bones and scales, and is known to be rich in nutrients, especially protein and fat (Taufiq et al., 2015).

However, fish fillets are very susceptible to damage due to their high water and fat content (Litaay et al., 2018). To maintain its quality, storage at low temperatures (5°–10°C) is a commonly used method, because it can inhibit the activity of enzymes and spoilage microorganisms (Gelman et al., 2001). However, some spoilage bacteria are still able to survive, so a combination of other methods is needed, such as the addition of natural preservatives (Adawyah, 2007).

Lactic acid bacteria (LAB) are known to be able to produce various antimicrobial compounds, such as lactic acid, diacetyl, hydrogen peroxide, and bacteriocins, which play a role in inhibiting the growth of bacteria that cause spoilage (Madigan and Martinko, 2003; Rachmawati et al., 2005; Sulistiani, 2017). LAB can grow well in acidic environments and require substrates such as carbohydrates to grow. Rice washing water contains carbohydrates, proteins, and vitamins that can still be utilized by LAB (Haryadi, 2006; Sitepu et al., 2021), but this waste has not been utilized optimally (Abror, 2018).

The addition of vinegar as a source of acetic acid can create optimal conditions for LAB growth. Vinegar is known to be able to lower the pH of the fermentation medium and inhibit the growth of spoilage microorganisms (Gao et al., 2020). Acetic acid in certain concentrations (0.2–0.3%) has been proven effective in inhibiting the growth of bacteria and fungi (Desniar et al., 2016). Therefore, the combination of fermented rice washing water and vinegar has the potential to be a natural preservative agent for fishery products.

This study aims to find the most optimal concentration of vinegar in fermented rice washing water, so that it can increase the shelf life of red tilapia fillets based on organoleptic characteristics during low temperature storage (5°–10°C). The results of this study are expected to provide a real contribution to the development of fishery product processing technology that is more environmentally friendly and has high economic value.

METHODS

Time and Place of Research

This research was conducted in July 2024. The preparation of fermentation solutions, the preparation of tilapia fillets, and storage were carried out at the Fisheries Product Processing Technology Laboratory. Microbial and pH testing was carried out at the Biotechnology Laboratory and the fish acclimatization process was carried out at the Aquaculture Laboratory, Faculty of Fisheries and Marine Sciences, Padjadjaran University.

Research Method

The method used in this research is an experimental method consisting of 5 treatments without repetition and parameter testing was carried out in duplicate. The tools used in this research include knives, containers, jar scales, cutting boards, measuring cups, Erlenmeyers, measuring pipettes, and petri dishes, while the research materials themselves include distilled water, tilapia, rice washing water, vinegar, and 70% alcohol.

Observations on organoleptic parameters based on Yuliana et al. (2015) were observed on days 1, 4, 7, 8, 9, 10, 11, 12, 13. The treatments given were soaking in a rice washing water fermentation solution with different vinegar concentrations based on the volume of the rice washing water fermentation solution for 30 minutes. The treatments are as follows:

A : Soaking with a rice washing water fermentation solution with a vinegar concentration of 0% (v/b)
B : Soaking with a rice washing water fermentation solution with a vinegar concentration of 0.5% (v/b)
C : Soaking with a rice washing water fermentation solution with a vinegar concentration of 1% (v/b)
D : Soaking with a rice washing water fermentation solution with a vinegar concentration of 1.5% (v/b)
E : Soaking with a rice washing water fermentation solution with a vinegar concentration of 2% (v/b)

The vinegar concentration was determined gradually to observe the effect of acid levels on the quality and shelf life of the material. Treatment 0% was used as a control, while concentrations of 0.5% to 2% were chosen because they are within the commonly used range and have the potential to inhibit the growth of microorganisms effectively.

Data Analysis

The analysis of organoleptic test results was carried out using a non-parametric approach, with the Friedman test as the main method to assess panelist preferences for the organoleptic characteristics of fillets. After that, multiple comparison tests were used to identify significant differences between treatments. The selection of the best treatment was determined through the Bayes test. All data obtained were analyzed comprehensively to assess the effectiveness of using fermented rice washing water as a natural preservative in extending the shelf life of red tilapia fillets. In addition, the results of this study were also compared with applicable quality standards to determine product advantages, as well as provide a basis for recommendations for further development in the fisheries processing industry sector.

RESULTS

Appearance

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

Table 1. Median and Average Values of the Appearance of Red Tilapia Fillets Based on the Treatment of Soaking in Fermented Rice Washing Water with the Addition of Different Concentrations of Vinegar During Low Temperature Storage (5°–10°C)

Concentration (%)	Median Value	Average Value
0	3	3.7 a
0.5	5	4.5 ab
1	5	5.7 b
1.5	5	4.9 b
2	3	5.3 ab

Aroma

The results of the aroma evaluation test of red tilapia fillets soaked in fermented rice washing water with various concentrations of vinegar, and stored at low temperatures (5°–10°C), are presented in Table 2.

Table 2. Median and Average Values of Red Tilapia Fillet Aroma Based on Soaking Treatment in Fermented Rice Washing Water with the Addition of Different Concentrations of Vinegar During Low Temperature Storage (5°–10°C)

Concentration (%)	Median Value	Average Value
0	3	2.1 a
0.5	3	3.7 ab
1	5	5.7 b
1.5	5	4.9 ab
2	3	3.7 ab

Texture

The results of the red tilapia fillet texture evaluation test soaked in fermented rice washing water with various vinegar concentrations, and stored at low temperatures (5°–10°C), are presented in Table 3.

Table 3. Median and Average Values of Red Tilapia Fillet Texture Based on Soaking Treatment in Fermented Rice Washing Water with the Addition of Different Vinegar Concentrations During Low Temperature Storage (5°–10°C)

Concentration (%)	Median Value	Average Value
0	3	2.1 a
0.5	3	3.7 ab
1	5	5.7 b
1.5	5	5.8 b
2	1	3.7 ab

Mucus

The results of the evaluation test of red tilapia fillet mucus soaked in fermented rice washing water with various concentrations of vinegar, and stored at low temperatures (5°–10°C), are presented in Table 4.

Table 4. Median and Average Values of Red Tilapia Fillet Mucus Based on Soaking Treatment in Fermented Rice Washing Water with the Addition of Different Concentrations of Vinegar During Low Temperature Storage (5°–10°C)

Concentration (%)	Median Value	Average Value
0	1	3.7 a
0.5	3	4.5 ab
1	5	5.7 b
1.5	5	4.9 b
2	3	5.3 ab

Bayes Test

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

Table 5. Decision Matrix for Red Tilapia Fillet Assessment

Treatment	Parameter				Alternative Values	Priority Values
	Appearance	Aroma	Texture	Mucus		
A	3	3	3	3	3.00	0.15
B	3	3	3	5	3.50	0.17
C	5	5	5	5	5.00	0.25
D	5	3	5	5	4.50	0.22
E	5	3	3	5	4.00	0.20
Criteria Value	0.34	0.43	0.17	0.22	19.38	1.00

DISCUSSION

Appearance

The appearance parameter is the first indicator observed by a panelist in the fillet acceptance test and determines the quality of fillet freshness. Based on Table 1. the results of the organoleptic test show that the addition of 0% vinegar concentration is significantly different from the 1% and 1.5% vinegar treatments, while the addition of 0.5% and 2% vinegar concentrations is not significantly different from the 0%, 1% and 1.5% treatments. In the appearance parameter, the treatment with the addition of 1% vinegar produced the highest average value of 5.7, indicating the best visual quality compared to other treatments. Conversely, the lowest value was recorded in the treatment without the addition of vinegar (0%) with an average of 3.7. The appearance value of the fillet will decrease along with the increasing storage period of the fillet (Liviawaty, 2001).

Soaking red tilapia fillets in a fermented solution of rice washing water with varying vinegar concentrations has been shown to be able to maintain the appearance of the fillets. The treatment without vinegar (0%) was only able to be maintained until the 7th day, marked by a change in color and a dull appearance. Meanwhile, treatments with concentrations of 0.5%, 1%, 1.5%, and 2% were still visually acceptable until the 10th day of storage. The appearance of the fillets that had the final acceptance limit showed characteristics of being rather dull, slightly bright with a pinkish tinge and blood stains on the brownish lateral line. The minimum quality requirement for organoleptic fresh fish fillets at low temperature storage is 5. The scoring test assessment was matched with the fresh fish fillet score sheet (Insani et al., 2016).

The appearance value decreased during the storage period, this was caused by the activity of microorganisms such as bacteria which increased drastically in number so that they underwent a decay process. Organoleptically, the appearance parameter value will decrease along with the biochemical process and the spike in the growth of pathogenic bacteria (Junianto, 2003). Research conducted by Rachmawati et al., (2016), on the decrease in organoleptic value for appearance, the activity of microorganisms in breaking down proteins so that myoglobin changes into metmyoglobin, causing the surface of the fillet to become dull. Oxidation reactions also affect color changes in tilapia fillets.

Aroma

Based on Table 2. the results of multiple comparison calculations show that the treatment with a vinegar concentration of 0% is significantly different from the treatment of vinegar concentration of 1% while the treatment of vinegar concentrations of 0.5%, 1.5%, and 2% is not significantly different from the treatment of 0% and 1%. The treatment of adding a vinegar concentration of 1% gave the best effect with the highest average value of 5.7 which is the best aroma compared to the treatment of adding other vinegar concentrations. The vinegar concentration of 0% is the lowest average aroma value of each treatment with a value of 2.1. Soaking in fermented rice water solution treated with different vinegar concentrations can maintain the aroma until the 7th day for 0% vinegar concentration, for 0.5% vinegar treatment until the 9th day and 1.5% and 2% vinegar concentrations until the 10th day while 1% vinegar concentration until the 11th day.

The aroma in tilapia fillets will change to a rotten aroma during the storage process. According to Erawati (2005), the estimated aroma parameters in fillets are the extent to which the culture applied to the product can continue to live and survive until the last day of storage. Changes in chemical compounds and microorganism activity are two factors that reduce the aroma value of red tilapia fillets during storage (Insani et al., 2016). Bacteria decompose fat and protein so that there is a change in the aroma of fish fillets. Microbial growth in food ingredients can produce an unpleasant aroma due to the decomposition process of proteins and other compounds found in fish meat (Buckle et al., 1987). According to Dwetro et al. (2017) the results of the decomposition of protein compounds by proteolytic enzymes into carboxylic acids, sulfide acids, ammonia and others. The aroma is produced from the enzymatic reaction process between protein and fat. Volatile compounds are the result of the decay process and cause a foul odor in fish meat (Suptijah et al., 2008).

Texture

Based on the calculation results in Table 3. Shows that the treatment of 0% vinegar concentration is significantly different from the concentration of 1% and 1.5% vinegar. The treatment of 0.5% and 2% vinegar concentrations is not significantly different from the treatments of 0%, 1% and 1.5%. Red tilapia fillets soaked in rice washing water fermentation solution have different acceptance limits. The treatment of 0% vinegar concentration has a shelf life of up to the 7th day, for the treatment of 0.5% vinegar until the 9th day and the concentration of 1.5% and 2% vinegar until the 10th day while the concentration of 1% vinegar until the 11th day. The best value for texture observation occurs at the addition of 1.5% concentration with a value of 5.8 and the lowest at 0% vinegar concentration of 2.1. The texture of fish fillets that have reached the final acceptance limit has characteristics that tend to be soft and slightly chewy. Texture changes for each treatment are different, changes in texture from hard to soft in fish fillets indicate that the fish meat has undergone a process of quality decline as seen from changes in appearance and aroma (Kalista et al., 2018).

The texture of the fillet will change as the shelf life increases. The autolysis process that occurs in fish meat will cause the texture of the meat to soften so that rotting occurs (Suptijah

et al., 2008). Erikson and Misimi (2008) explained that the absence of a frame that supports the fish meat and the muscle contractions that occur cause the fish meat to shrink and its texture to change. The high-water content in fish meat tends to cause the texture to become soft and tender, while the low water content generally produces a harder and stiffer texture. (Derwin et al., 2022). Ilyas (1983) added that the main factor that causes texture changes is the fish meat tissue that can no longer hold water. Red tilapia fillets are said to be no longer fresh if their texture feels soft and inelastic (Liviawaty, 2001).

Mucus

Mucus is a parameter that can help see the freshness and quality decline of red tilapia fillets. Based on Table 4. the results of the multiple comparison test on the parameters of red tilapia fillet mucus show that the treatment with the addition of 0% vinegar concentration is significantly different from the treatment of 1% and 1.5% while the treatment of 0.5% and 2% vinegar concentration is not significantly different from the treatment of 0%, 1% and 1.5%. Observation of mucus in the 1% vinegar concentration treatment is the best treatment compared to other treatments with a value of 5.7 and the lowest value in the 0% vinegar concentration treatment of 3.7.

The mucus on the tilapia fillet at the beginning of storage shows a condition that is still fresh with characteristics that are not slimy and the liquid is homogeneous and clear. During the longer storage period, the mucus on the fillet changes during storage until the day of acceptance because the decay process has taken place. The bacteria in the fish mucus will continue to increase so that the decay process runs quickly, making the mucus thicker and brownish in color and not transparent (Litaay et al., 2017). In the early stages of decay, a condition known as hyperemia occurs, where mucus on the fish's body begins to come out of the glands in its skin. The mucus then forms a fairly thick clear layer on the surface of the fish's body. This layer becomes a medium that is very supportive for bacterial growth (Murniyati & Sunarman, 2000).

Bayes Test

The results of the calculation of the parameters of appearance, aroma, mucus, and texture show that aroma has the highest weight, which is 0.43, making it the most important aspect in the panelist's assessment. The next parameters considered important are appearance (0.34), followed by mucus (0.22), and texture (0.17). This indicates that aroma is the main consideration in evaluating the quality of fish fillets.

Through analysis using the Bayes method, it is known that red tilapia fillets soaked in a fermented solution of rice washing water with the addition of 1% vinegar are the most preferred treatment by panelists. This treatment obtained the highest alternative value of 5.00 and a priority value of 0.25. The next position is occupied by the treatment with 1.5% and 2% vinegar concentration (values 4.50 and 4.00), while the treatment without vinegar (0%) is the lowest with a value of 3.00. Thus, the addition of 1% vinegar is considered the most effective in increasing consumer preference for red tilapia fillets.

The results of organoleptic observations covering appearance, aroma, mucus, and texture showed that the addition of vinegar in the rice washing water fermentation solution had a significant positive effect on the quality of the fillet. This treatment not only helped maintain organoleptic quality, but also extended the shelf life of fish fillets. The Bayes method in this case was effective in updating beliefs based on the results of the panelist test, and showed that the treatment with 1% vinegar had the highest probability of being preferred.

CONCLUSION

The results showed that the fermented solution of rice washing water with the addition of vinegar was effective in extending the shelf life of red tilapia fillets. Treatment with a vinegar concentration of 1% gave the best results, with the ability to maintain fillet quality until the 11th day of storage. The effectiveness of this treatment is reflected in the results of organoleptic tests covering appearance, mucus, aroma, and texture, making it a potential natural preservation method at low temperatures.

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REFERENCES

Abror, M., & Harjo, R. P. (2018). Efektivitas Pupuk Organik Cair Limbah Ikan dan *Trichoderma Sp.* terhadap Pertumbuhan dan Hasil Tanaman Kailan (*Brassica oleraceae* sp.). Fakultas Pertanian, Universitas Muhammadiyah Sidoarjo.

Adawyah, R. (2007). *Pengolahan dan Pengawetan Ikan.* Bumi Aksara.

Buckle, K. A., Edwards, R. A., Fleet, G. H., & Wooton, M. (1987). *Ilmu Pangan.* Universitas Indonesia Press.

Derwin, C., Palenewen, J. C. V., Onibala, H., Dien, H. A., Pandey, E., & Mentang, F. (2022). Mutu mikrobiologi dan organoleptik fillet ikan tuna sirip kuning (*Thunnus albacores*) selama penyimpanan suhu dingin. *Jurnal Perikanan dan Kelautan Tropis,* 12(1), 14–23.

Desniar, Setyaningsih, I., & Purnama, Y. I. (2016). Penapisan dan Produksi Antibakteri *Lactobacillus plantarum* NS (9) yang diisolasi dari Bekasam Ikan Nila Atin. *Jphpi,* 19(2), 132–139.

Dwetro, G. R., Suparmi, & Sumarto. (2019). Pengaruh Penambahan Ekstrak Daun Kemangi terhadap Daya Awet Ikan Nila (*Oreochromis niloticus*) Segar. *Jurnal Biologi, Pendidikan dan Terapan,* 6(1).

Erikson, U., & Misimi, E. (2008). Atlantic salmon skin and fillet color changes effected by perimortem handling stress, rigor mortis, and ice storage. *Journal of Food Science,* 73(2), 50–59.

Fauziah, M., Lili, W., Rosidah, Herawati, T., & Suryadi, I. B. B. (2018). Effectiveness of comercial probiotics on maintenance media against survival and growth of red tilapia fingerlings (*Oreochromis niloticus*). *Global Scientific Journals,* 6(7), 1011–1018.

Gelman, A., Glatman, L., Drabkin, V., & Harpaz, S. (2001). Effects of Storage Temperature and Preservative Treatment on Shelf Life of the Pond-Raised Freshwater Fish, Silver Perch (*Bidyanus bidyanus*). *Journal of Food Protection,* 64(10), 1584–1591.

Haryadi. (2006). *Teknologi Pengolahan Beras.* Gadjah Mada University Press.

Ilyas, S. (1993). *Teknologi Refrigerasi Hasil Perikanan Jilid I: Teknik Pendinginan Ikan.* Pusat Penelitian dan Pengembangan Perikanan.

Insani, M. (2016). Penggunaan Ekstrak Daun Belimbing Wuluh terhadap Masa Simpan Filet Patin Berdasarkan Karakteristik Organoleptik. *Jurnal Perikanan dan Kelautan,* 7(2).

Kalista, A., Amin, R., & Umi, R. (2018). Analisis Organoleptik (Scoring Test) Tingkat Kesegaran Ikan Nila Selama Penyimpanan. *Fischtech – Jurnal Teknologi Hasil Perikanan,* 7(1), 98–103.

Litaay, C., Wisudo, S. H., Haluan, J. H., & Harianto, B. (2018). The Effects of Different Chilling Method and Storage Time on the Organoleptic Quality of Fresh Skipjack Tuna. *Jurnal Ilmu dan Teknologi Kelautan Tropis,* 9(2), 717–726.

Liviawaty. (2001). Optimasi Proses Pembuatan Asap Cair dari Tempurung Kelapa sebagai Pengawet Makanan dan Prospek Ekonomisnya. *Agroteksos,* 22(1).

Madigan, M. T., Martinko, J. M., & Parker, J. (2003). *Brock Biology of Microorganism.* Prentice Hall Inc.

Murniyati, & Sunarman. (2000). *Pendinginan, Pembekuan, Pengawetan Ikan.* Kanisius.

Rachmawati, I., & Setyaningsih, R. (2005). Uji Antibakteri Bakteri Asam Laktat asal Asinan Sawi terhadap Bakteri Patogen. *Bioteknologi,* 2(2), 43–48.

Suptijah, P., Gushagia, Y., & Sukarsa, D. R. (2008). Kajian efek daya hambat kitosan terhadap kemunduran mutu fillet ikan patin (*Pangasius hypopthalmus*) pada penyimpanan suhu ruang. *Buletin Teknologi Hasil Perikanan,* 11(2), 89–101.

Taufiq, A., Lestari, M., & Prasetyo, S. (2015). Nutritional Benefits of Fish Fillets: Protein and Fat Content. *Journal of Seafood Science,* 12(3), 225–235.

Yuliana, G., Afrianto, E., & Pratama, I. R. (2015). Aplikasi Kombinasi Bakteri Asam Laktat, Natrium Klorida dan Natrium Asetat terhadap Masa Simpan Ikan Patin (*Pangasius hypophtalmus*) pada Suhu Rendah. *Jurnal Perikanan Kelautan,* 1(2), 85–90.