Fisheries Journal, 15 (2), 679-689 (2025)
http://doi.org/10.29303/jp.v15i2.1413

THE USE OF RICE WASHING WATER FERMENTATION SOLUTION AND VINEGAR ON THE SHELF LIFE OF RED TILE FILET BASED ON THE NUMBER OF MICROBES IN LOW TEMPERATURE STORAGE

Penggunaan Larutan Fermentasi Air Cucian Beras dan Cuka Terhadap Masa Simpan Filet Nila Merah Berdasarkan Jumlah Mikroba Pada Penyimpanan Suhu Rendah

Abraham Luther[1*], Evi Liviawaty[2], Kiki Haetami[3]

Fisheries Study Program Padjadjaran University

Bandung Sumedang Highway KM 21, Hegarmanah, Jatinangor, Sumedang 45363

[*]Corresponding Author: abraham20001@mail.unpad.ac.id

(Received February 12th 2025; Accepted April 27th 2025)

ABSTRACT

Tilapia fillets are very susceptible to quality degradation. Therefore, efforts need to be made to maintain the quality of tilapia fillets with preservation methods using natural materials such as rice washing water waste. Rice washing water added with vinegar can grow lactic acid bacteria (LAB) through a fermentation process where LAB can fight spoilage bacteria in processed fishery products. The purpose of this study was to determine the use of optimal vinegar concentration in rice washing water fermentation solution to extend the shelf life of tilapia fillets based on the number of bacteria and pH during low temperature storage. The research method used in this study is a descriptive method. The treatment used was the addition of 0%, 0.5%, 1%, 1.5%, 2% vinegar solution and stored at low temperatures (5°-10°C). The parameters measured included the number of bacterial colonies and the degree of acidity (pH). Concentration 0% observation was conducted on days 1, 3, 6, 7, 8, 9 while for concentrations 0.5%, 1%, 1.5%, 2% observations were conducted on days 1, 4, 7, 8, 9, 10, 11, and 12. The results showed that the fermentation solution of rice washing water with the addition of 1% vinegar concentration was the best for extending shelf life. The treatment of 1% vinegar concentration can maintain the quality of red tilapia fillets until the 11th day with a total of 5.6×10^7 bacteria and a pH value of 6.70.

Key words: Fermentation, LAB, Low Temperature, Microbial Count, Red Tilapia Fillet, pH

ABSTRAK

Filet nila sangat rentan mengalami penurunan mutu. Oleh karena itu perlu dilakukan upaya untuk mempertahankan mutu dan kualitas filet nila dengan metode pengawetan menggunakan bahan alami seperti limbah air cucian beras. Air cucian beras yang ditambahkan cuka dapat menumbuhkan bakteri asam laktat (BAL) dengan proses fermentasi yang dimana BAL dapat melawan bakteri pembusuk pada produk olahan perikanan. Tujuan penelitian ini adalah menentukan penggunaan konsentrasi cuka yang optimal pada larutan fermentasi air cucian beras untuk memperpanjang masa simpan filet nila berdasarkan jumlah bakteri dan pH selama penyimpanan suhu rendah. Metode penelitian yang digunakan dalam penelitian ini adalah metode deskriptif. Perlakuan yang digunakan adalah penambahan larutan cuka 0%, 0,5%, 1%, 1,5%, 2% dan disimpan dalam suhu rendah (5°-10°C). Parameter yang diukur meliput jumlah koloni bakteri dan derajat keasaman (pH). Konsentrasi 0% pengamatan dilakukan pada hari ke-1, 3, 6, 7, 8, 9 sedangkan untuk konsentrasi 0,5%, 1%, 1,5%, 2% dilakukan pengamatan pada hari ke-1, 4, 7, 8, 9, 10, 11, dan 12. Hasil penelitian menunjukkan bahwa larutan fermentasi air cucian beras dengan penambahan cuka konsentrasi 1% adalah yang terbaik untuk memperpanjang masa simpan. Perlakuan konsentrasi cuka 1% dapat mempertahankan mutu filet nila merah hingga hari ke-11 dengan total bakteri $5{,}6\times10^7$ dan nilai pH sebesar 6,70.

Kata Kunci: BAL, Fermentasi, Filet nila merah, Jumlah Mikroba, pH, Suhu Rendah

INTRODUCTION

Red tilapia is one of the many types of fish that has a thick meat texture with a small number of bones so that it can be processed into a product. One of the processed products from tilapia is red tilapia fillet. Red tilapia fillet is a piece of red tilapia meat that has been separated from bones, scales and other unwanted materials. Fish fillets are obtained by slicing the fish meat whole along the spine starting from the head to the tail (Moeljanto, 1992). There are several types of fillets sold on the market, namely with skin on and without skin (skin less). The fillet product itself has several advantages in terms of nutritional content, namely containing protein and fat (Taufiq *et al.*, 2015).

Various efforts have been made to increase the shelf life of fresh fish, including the use of low temperatures (5°-10°C) and the addition of antibacterial materials as preservatives. The use of low temperatures has been proven to inhibit the process of quality decline by inhibiting the activity of enzymes and spoilage bacteria (Gelman *et al.*, 2001). However, there are several types of spoilage bacteria that can survive at low temperatures, therefore the use of low temperatures needs to be combined with other preservation methods, one of which is by utilizing microbes. One way to utilize microbes as preservatives is to use lactic acid bacteria (LAB). LAB has compounds that can inhibit spoilage bacteria that cause fish damage (Madigan & Martiko, 2003). Bacteriocin compounds produced by lactic acid bacteria (LAB) are very useful for suppressing the growth of pathogenic bacteria that can damage the quality of fishery products, especially tilapia (Sulistiani, 2017).

There are many alternative antibacterial materials that can be used to preserve food, one of which is by utilizing materials around us such as organic waste. One type of abundant organic waste is rice washing water. Rice washing water contains many substances that can still be utilized, including carbohydrates, proteins and vitamins. Carbohydrates that are eroded during the rice washing process can be used by LAB to reproduce (Sitepu *et al.*, 2021). LAB has an optimum pH for growth of 3-4, this pH is a good condition for microbial growth, especially lactic acid bacteria such as lactobacillus and streptoccus (Roni & Herawati, 2012). The addition of acidic compounds to organic waste media can lower the pH, creating an environment that is suitable for LAB and less suitable for decomposing bacteria (Samsuri *et al.*, 2007).

In general, people are more familiar with acetic acid (vinegar) than other types of acidic compounds. Kitchen vinegar (CH_3COOH) is a type of vinegar that is commonly used for food mixtures and as a preservative. Based on the National Standardization (SNI 01-4371:1996) regarding vinegar quality standards, it states that the requirement for acetic acid concentration in vinegar solution is at least 4%. According to research conducted by Desniar *et al*., (2016), acetic acid with a concentration of 0.2% can inhibit the growth of putrefying bacteria while a concentration of 0.3% acetic acid can inhibit the growth of fungi.

Based on the description above, a study was conducted on the use of fermented rice washing water solution with the treatment of adding vinegar concentration used as a natural preservative for tilapia fillets. The parameters observed in this study were the total number of microbes (Total Plate Count) and the degree of acidity (pH). The purpose of this study was to determine the optimal use of vinegar concentration in rice washing water fermentation solution to extend the shelf life of red tilapia fillets based on total microbes and pH during storage at low temperatures (5°-10°C).

RESEARCH METHODS

Time and Place

This research was conducted in July 2024. The preparation of fermentation solution, making tilapia fillets, 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 Procedures

The method used in this study is an experimental method consisting of 5 treatments without repetition and parameter testing is carried out in duplicate. The absence of repetition in this study is due to several factors, such as limited materials and time, and the focus of the study which is more directed at initial exploration to see the trend of changes due to treatment. Although without repetition, this study still uses duplicate testing to increase data reliability and reduce the possibility of measurement errors.

The treatment given is immersion in a rice washing water fermentation solution with different vinegar concentrations based on the volume of rice washing water fermentation solution for 30 minutes. The treatments are as follows:

A: Soaking with a fermented rice washing water solution with a vinegar concentration of 0% (v/b)

B: Soaking with a fermented rice washing water solution with a vinegar concentration of 0.5% (v/b)

C: Soaking with a fermented rice washing water solution with a vinegar concentration of 1% (v/b)

D: Soaking with a fermented rice washing water solution with a vinegar concentration of 1.5% (v/b)

E: Soaking with a fermented rice washing water solution with a vinegar concentration of 2% (v/b)

Observations on parameters based on Yuliana *et al.*, (2015) on the control were carried out on days 1, 3, 6, 7, 8, 9, while observations for the treatment of adding fermented rice washing water and vinegar (0.5% -2%) were observed on days 1, 4, 7, 8, 9, 10, 11, 12, 13. Observations were not carried out every day at the beginning of the observation because there had been no changes significant on the total number of bacteria and pH value.

Data Analysis

The data obtained in the study were then analyzed using a comparative descriptive method and presented in a table to see the comparison based on pH and total bacteria. The descriptive analysis method is carried out to compare the similarities and differences between two or more facts of the objects studied based on a certain framework of thought, by describing, to find the elements then analyzed and drawn conclusions (Irsyadi, 2012).

RESULT

Degree of Acidity (pH)

Soaking red tilapia fillets in fermented rice water solution added with vinegar at various concentrations affects the quality of the fillets during storage. The results of pH testing of red tilapia fillets during storage at low temperatures are presented in Table 1.

Table 1. Average Acidity Degree (pH) Value of Red Tilapia Fillets Treated by Soaking in Rice Washing Water Fermentation Solution with Different Vinegar Concentrations During Low Temperature Storage (5°-10°C).

Day No-	Vinegar Concentration in Rice Washing Water Fermentation Solution (%)				
	0	0,5	1	1,5	2
1	6,40	6,15	6,10	5,90	5,80
3	6,15	-	-	-	-
4	-	5,95	5,90	5,75	5,50
6	6,20	-	-	-	-
7	**6,65**	6,35	5,95	6,00	5,75
8	6,90	6,50	6,15	6,30	6,20
9	7,05	**6,55**	6,35	6,60	6,45
10	-	6,85	6,55	**6,70**	**6,65**
11	-	6,95	**6,70**	6,90	7,00
12	-	7,10	7,05	7,00	7,10

Description:
- = pH measurement not performed
Bold number = pH acceptance day limit

Total Number of Bacteria

The total bacterial content in food ingredients is an important indicator that can be used as a reference in determining the safety of a material if it meets the established quality requirements. Red tilapia fillets that have been soaked in a fermented solution of rice washing water with added vinegar concentrations gave different results in testing the number of microbial colonies. The results of observations of the total number of bacteria in red tilapia fillets soaked in different vinegar concentrations are presented in Table 2.

Table 2. Total Number of Bacteria (cfu/g) of Red Tilapia Fillets Treated by Soaking in Rice Washing Water Fermentation Solution with Different Vinegar Concentrations During Low Temperature Storage (5°-10°C).

Storage Day-	Vinegar Concentration (%)				
	0	0,5	1	1,5	2
1	$5,0\times10^{4}$	$4,5\times10^{4}$	$3,3\times10^{4}$	$3,7\times10^{4}$	$3,9\times10^{4}$
3	$3,8\times10^{5}$	-	-	-	-
4	-	$4,8\times10^{4}$	$3,7\times10^{4}$	$4,1\times10^{4}$	$4,5\times10^{4}$
6	$6,2\times10^{5}$	-	-	-	-
7	**$4,1\times10^{6}$**	$4,9\times10^{5}$	$3,6\times10^{5}$	$2,9\times10^{6}$	$3,2\times10^{6}$
8	$2,4\times10^{7}$	**$3,4\times10^{6}$**	$2,3\times10^{6}$	$2,7\times10^{6}$	$3,8\times10^{6}$
9	*	$3,7\times10^{7}$	$3,7\times10^{6}$	**$5,5\times10^{6}$**	**$5,9\times10^{6}$**
10	*	$2,0\times10^{8}$	**$5,0\times10^{6}$**	$3,8\times10^{7}$	$2,2\times10^{8}$
11	*	$1,9\times10^{9}$	$5,6\times10^{7}$	$2,1\times10^{9}$	$4,2\times10^{8}$
12	*	$2,3\times10^{9}$	$4,2\times10^{8}$	$2,4\times10^{9}$	$2,4\times10^{9}$

Description:
- = TPC testing was not carried out
* = TPC testing was not carried out because on the previous day the total number of microbes had reached the acceptance limit

DISCUSSION

Degree of Acidity (pH)

The results of measuring the acidity level in red tilapia fillets showed that the pH value of red tilapia fillets soaked in fermented rice washing water solution treated with different concentrations of vinegar and stored at low temperatures had varying values. The first day of storage for each treatment was between 5.80-6.40. Increasing the concentration of vinegar caused a decrease in the pH value. This happened because the fermented rice washing water solution when applied to red tilapia fillets had a pH value ranging from 3.70-4.10. In addition, vinegar as an environmental controller caused the environmental conditions during the fermentation process to be optimal for the growth of lactic acid bacteria. In the growth process, LAB will decompose lactose into lactic acid, this condition causes a decrease in the pH value (Hidayat *et al.*, 2013). Wibowo (2012), stated that the optimum pH for the growth of lactic acid bacteria is in the range of 4.00-5.00 so that it can compete with pathogenic bacteria that live at an optimum pH of around 7.20-7.60.

LAB is a bacteria that has antagonistic properties so that it can stop the activity of putrefying bacteria. According to Afrianto (2010), there are several mechanisms carried out by lactic acid bacteria to fight putrefying bacteria. LAB produces metabolite compounds that are toxic to putrefying bacteria. In addition, compounds produced by LAB can lower the pH of the environment so that pathogenic bacteria cannot survive. Third, lactic acid bacteria cause competition in food, so that putrefying bacteria do not have the opportunity to get food.

Red tilapia filet has a pH acceptance limit of 6.70. Determination of pH acceptance limits is based on several studies on red tilapia fillets. Based on research by Lestary (2011), untreated red tilapia fillets have a shelf life of up to 7 days with a pH value of 6.70. The results of this research are in line with those carried out by Wanabhakti (2011), that red tilapia fillets without treatment and stored at low temperatures can last until the 7th day with a pH value of 6.70.

Another study conducted by Windiyasari (2011) showed that untreated red tilapia filets could maintain a shelf life of up to 7 days with a pH value of 6.75. In this study, the lowest and longest decrease in pH to reach a value of 6.70 occurred in red tilapia fillets treated with 1% vinegar concentration.

The pH value of red tilapia fillets treated with 0% vinegar concentration was 6.65 and could maintain shelf life until the 7th day. Red tilapia fillets soaked in rice water fermentation solution with the addition of 0.5% vinegar concentration could last until the 9th day with a pH value of 6.55. Treatment with the addition of 1% vinegar concentration could maintain shelf life until the 11th day with a pH value of 6.70. Treatment with the addition of 1.5% and 2% vinegar concentrations showed the same shelf life, namely until the 10th day with pH values of 6.70 and 6.65, respectively.

The pH value of red tilapia fillets during the 12-day storage period ranged from 5.80-7.10. Based on the results of this study, all treatments of soaking red tilapia fillets with different vinegar concentrations had the same pattern of decreasing and increasing pH values. During the storage process at low temperatures from day 1 to day 4, the pH of red tilapia fillets showed a decrease with values ranging from 5.50-6.40 then continued to increase until the 12th day of storage. This is due to the glycolysis process that occurs in red tilapia fillets and the degradation of adenosine triphosphate, creatine and phosphoric acid which produces a series of acidic substances (Zhang *et al.,* 2011). During the storage period, the acidity value of red tilapia fillets decreases due to the activity of the glucokinase enzyme which converts glycogen into lactic acid which will accumulate over time as a result of its decomposition so that the accumulation of decomposed lactic acid will cause the pH to decrease, thereby slowing down the deterioration process or decline in quality in fish meat (Asni *et al.,* 2022). Glycogen reserves in fish meat will affect its pH value. When glycogen reserves are low, fish meat will quickly deteriorate until it finally rots (Asni *et al.,* 2022). A longer pH decrease indicates that the rigor mortis process occurs longer, thus slowing down the decline in quality due to bacteria and allowing the shelf life of fish meat to be longer (Santoso *et al.*, 2017).

After the pH in the red tilapia fillet decreased until the 4th day, from the 5th to the 12th day of storage the pH began to increase until it reached a neutral pH value. The increase in the pH value in the red tilapia fillet was caused by the glycogen reserves having been completely decomposed so that there was no more formation of lactic acid in the red tilapia fillet. Research by Asni *et al.,* (2022), also stated that the acidity value in fish meat would decrease to reach pH 5.00 and then increase to exceed pH 7.00 or neutral. The increase in pH value is in line with the growth of putrefactive bacteria that live at an optimal pH of 6.80 (Parija, 2012).

The decrease in pH value in red tilapia fillets during storage was also caused by soaking in a fermented solution of rice washing water combined with vinegar at various concentrations. Vinegar is an acetic acid that is used as an environmental control and plays a role in lowering the pH of the environment so that it is suitable for the growth of LAB that live in the pH range of 3.00-6.00 (Buckle *et al.,* 1987). Research by Hendarto *et al.,* (2019), stated that LAB, especially the *L. bulgaricus* type, can reach optimal conditions at pH 5.50. Acetic acid applied to fish meat will affect the quality and stability of the pH of the fish meat during storage (Hakim *et al.,* 2016).

The decrease in pH value that occurred in the 1% vinegar concentration treatment was due to the level of acetic acid or vinegar added being suitable for the growth of lactic acid bacteria. The decrease in the quality of red tilapia fillets, in addition to being indicated by an increase in pH value, was also followed by a significant change in aroma in each treatment after passing the acceptance day limit due to the increase in the amount of ammonia. Dangur *et al.*, (2020), stated that bacterial metabolism results in the formation of ammonia compounds (NH_3) which cause fish fillets to emit a foul odor.

Total Number of Bacteria

The total number of bacteria from all treatments during 12 days of storage at low temperature (5°-10°C) ranged from 3.3x104 to 2.4×109 cfu/gram. The results showed that red tilapia fillets with the addition of 0% vinegar concentration were still edible until the 7th day with a total of 4.1×106 bacteria, while tilapia fillets treated with 0.5% vinegar concentration were still edible until the 8th day with a total of 3.4×106 bacteria. Tilapia fillets treated with 1% vinegar concentration had a longer shelf life compared to those with the addition of 0% and 0.5% vinegar concentrations, namely until the 10th day. As the concentration of vinegar increases, the shelf life of red tilapia fillets does not increase, this can be seen in the addition of vinegar concentrations of 1.5% and 2%, the consumption limit of red tilapia fillets shows faster results than the 1% vinegar concentration, which is only up to the 9th day with the number of bacteria respectively 5.5 × 106 and 5.9 × 106. The consumption limit of red tilapia fillets based on the total number of bacteria refers to research by Connel (1990) and SNI 2696 (2020) which states that the number of bacteria in food ingredients that are still safe and suitable for consumption is 106 cfu/gram. The total number of bacteria during storage at low temperatures will increase along with the increasing days of storage, this is because the environment for bacterial growth is optimal (Munandar *et al.*, 2009). On the 1st to 4th day of storage, an increase in the number of bacterial colonies began to be seen and after that bacterial growth increased rapidly until the 12th day of storage.

In addition to the total number of microbes exceeding the consumption limit of 106, there are other factors that can be linked to see the shelf life of red tilapia fillets, namely the organoleptic value in the form of aroma. Aroma is an important factor in determining the freshness of fish where if a rotten aroma is smelled, it indicates that the quality of the fish meat has decreased (Kalista *et al.*, 2018). The results of aroma observations from each treatment showed that the aroma of red tilapia fillets that were at the consumption limit still had a neutral fish aroma and had not yet smelled an aroma that indicated decay. The high number of microbes in each treatment cannot be directly concluded that the red tilapia fillets are no longer edible, this is because the media used in bacterial culture uses nutrient agar (NA) media. NA is a growth medium used to grow various types of microorganisms (Cowan & Steel, 2004). Based on the results of pH observations (Table 2) shows a pH value that tends to be acidic, so that the microbes that grow are dominated by lactic acid bacteria.

The difference in shelf life results in each treatment is due to the different concentrations of vinegar in the rice washing water fermentation solution. The 1% vinegar concentration is the treatment with the longest shelf life with the lowest total number of bacteria, which is 5×106 compared to other treatments and can maintain shelf life until the 10th day. This condition can be due to the addition of vinegar in the fermentation process of rice washing water with a concentration that is too low or too high can interfere with the activity of lactic acid bacteria, thereby reducing the effectiveness of fermentation and product quality. LAB is a type of bacteria that lives in an acidic environment, but in acidity conditions that are too low more than 6 and too high less than 3, LAB cannot survive and die (Aliya *et al.*, 2015). According to Hadi

(2019), the concentration of vinegar in the fermentation process must be calculated properly according to the standards required in order to achieve effectiveness in the fermentation process and improve product quality.

Leesmith (2005), stated that the addition of 1% acetic acid concentration can slow the growth of unwanted bacteria such as *S. aureus, L. monocytogenes,* and *E. coli*. In this study, 1% vinegar concentration is a superior concentration compared to other vinegar concentrations to inhibit the growth of spoilage bacteria because the environment is not optimal, but suitable for the growth of LAB. LAB in its growth process produces organic acid compounds in the form of lactic acid which can reduce the pH value of the environment so that it can inhibit the growth of pathogenic bacteria that cannot survive at an acidic pH (Nadia *et al.,* 2020). In addition to lactic acid compounds, LAB can also produce compounds that can inhibit the growth of spoilage bacteria, such compounds include hydrogen peroxide, carbon dioxide, diacetyl and bacteriocin (Suryaningsih *et al.,* 2019).

Based on the results of preliminary research, rice washing water added with vinegar and stored for five days has undergone a spontaneous fermentation process with a total of 4.5 × 108 bacteria until the fifth day of fermentation. Spontaneous fermentation is a type of fermentation that occurs naturally without the addition of microbial starters and grows naturally in media that has been conditioned so that certain types of microbes can grow well through the fermentation process (Rustan, 2013). According to Purwohadisantoso (2009), seen from the type of fermentation, LAB that develops during the fermentation process and produces metabolites in the form of lactic acid as a result of glucose fermentation is called homofermentative. In addition, to see whether the fermentation process occurs in rice washing water so that lactic acid bacteria can grow and develop can be seen through research conducted by Watanabe *et al.,* (2013), where the results of the study showed that fermentation of rice washing water for three days can grow 150 isolates of lactic acid bacteria and in research conducted by Ikeda *et al.,* (2013), stated that fermentation of washing water for 3-5 days produces lactic acid bacteria that grow more dominantly than other microorganisms.

L. plantarum is a type of lactic acid bacteria that lives in the pH range of 4-4.5 (Buchannon & Gibbsons, 1990). Fermentation of washing water with vinegar concentrations of 1% and 1.5% has an acidity value at the beginning of fermentation of 4.3 and 4.1 which is within the optimum pH range for LAB growth while a vinegar concentration of 2% has an initial pH value of 3.9 so it is less suitable for LAB growth. LAB will grow in a suitable environment, this can be proven by the treatment of 1% vinegar concentration in preliminary research resulting in a total number of lactic acid bacteria of 4.5×10^{8} while the treatment of 2% vinegar concentration produced a total of 4.1×10^{8}.

Red tilapia fillets soaked in rice washing water fermentation solution with the addition of 0% vinegar concentration showed faster microbial growth compared to other vinegar concentration treatments. The treatment of 0% vinegar concentration or without the addition of vinegar makes the red tilapia fillet have an acceptance limit until the 7th day with a total of 4.1×10^{6} bacteria. The absence of vinegar in the 0% concentration treatment causes bacterial growth to increase rapidly. As long as environmental conditions are supportive, lactic acid bacteria can still grow and develop. Rice washing water contains many substances that can still be utilized, including carbohydrates, proteins and vitamins. Carbohydrates that are eroded during the rice washing process can be used by lactic acid bacteria to grow and develop (Sitepu *et al.*, 2021). Pratama *et al.*, (2013), stated that cassava fermentation without the addition of vinegar can still grow lactic acid bacteria.

The use of vinegar in fermentation media acts as an environmental controller because its acidic nature can lower the pH in rice washing water fermentation so that environmental conditions are suitable and optimal for the growth of lactic acid bacteria. Controlling the fermentation environment is carried out to create conditions that prevent spoilage microbes from surviving, while fermentation microbes can grow and develop optimally (Suprihatin, 2010). Gao *et al*,. (2020), stated that vinegar is one of the many ingredients that can be used to control the fermentation process in various fishery products. The higher the addition of vinegar concentration to the fermentation solution using rice washing water applied to red tilapia fillets did not provide superior results compared to 1% concentrated vinegar which has an acceptance limit of up to day 10, this is evidenced by the treatment of 1.5% and 2% vinegar concentrations which can only maintain shelf life up to day 9.

Storage at low temperatures (5°-10℃) is one of the things that affects bacterial development during the storage process of red tilapia fillets. According to Supardi and Sukamto (1999), there are several types of bacteria in the refrigerator, namely psychrophilic and psychrotrophic bacteria. Both groups of bacteria are able to survive at cold temperatures so that red tilapia fillets that have been packaged and stored in the refrigerator will remain contaminated and undergo a rotting process. Psychrotrophic bacteria are bacteria that can live at minimum temperatures (-4°- (5)°C), optimum temperatures (25°-30°C) and maximum temperatures in the range (30°-35°C) (Prescott *et al.*, 2005). Psychrophilic bacteria are bacteria that can live at temperatures below 50ºC, but their optimum temperature is in the range of 10°-25°C and in certain conditions can live at higher temperatures (Sopandi & Wardah, 2014). According to Afrianto & Liviawaty (2010), the total number of bacteria will generally decrease during the cooling and freezing process, but this decrease only occurs in mesophilic and thermophilic bacteria. The types of microbes that are often found in fishery products that cause spoilage are *Micrococcus, Psedomonas, Flavobacterium, Archrobacter* and *Corynefor* (Afrianto, 2010).

CONCLUSION

Based on the results of the research that has been done, it can be concluded that the fermented solution of rice washing water added with vinegar with a concentration of 1% is the best for extending the shelf life based on the total number of microbes and the degree of acidity (pH). The treatment of 1% vinegar concentration can maintain the quality of red tilapia fillets until the 11th day of storage with a total of 5.6×107 microbes and a pH value of 6.70.

ACKNOWLEDGEMENTS

I would like to express my gratitude to all parties who have played a role in the research and preparation of this article, especially to the supervising lecturer for his guidance and direction, as well as colleagues who have provided support and cooperation. Hopefully the contributions and assistance given will be useful good deeds.

REFERENCES

Afrianto E, & Liviawaty E. (2010). *Penanganan Ikan Segar*. Bandung: Widya Padjadjaran.

Aliya, H., Nisaul, M., & Tiwi, N. (2015). Pemanfaatan Asam Laktat Hasil Fermentasi Limbah Kubis Sebagai Pengawet Anggur dan Stroberi. *Bioedukasi*, 9(1), 23-28.

Buchanan, R. E., & Gibbons, N. E. (1990). *Bergey's Manual of Systematic Bacteriology*. USA: Williams & Wilkins.

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

Connell, J. J. (1990). *Control Fish Quality*. London: Fishing News Book.

Cowan, S. T., & Steel, K. J. (2004). *Manual for the Identification of Medical Bacteria*. Cambridge University Press.

Dangur, S. T., Kallau, N. H. G., & Wuri, D. A. (2020). Pengaruh Infusa Daun Kelor (Moringa Oleifera) Sebagai Preservatif Alami Terhadap Kualitas Daging Babi. *Jurnal Kajian Veteriner*, 8(1), 1–23.

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

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.

Hadi, A. S. (2019). Pengaruh Konsentrasi Asam Cuka terhadap Sifat Kimia, Mikrobiologi, dan Organoleptik Telur Pindang Asam (*Pickle Egg*). *Skripsi.* Fakultas Teknologi Pangan dan Agroindustri, Universitas Mataram, Mataram.

Hakim, M. L. A., Rofandi, H., & Edhi, N. (2016). Pengaruh Penggunaan Asam Asetat dan Edible Coating Ekstrak Bawang Putih terhadap Kualitas Fillet Ikan Nila Merah (*Oreochromis niloticus*) Selama Penyimpanan Suhu dingin. *Jurnal Teknologi Hasil Pertanian*, 9(1), 24-33.

Hendarto, D., Arita, P., Elisa, P, H., Yoga, A., H. (2019). Mekanisme Biokimiawi dan Optimalisasi *Lactobacillus Bulgaricus* dan *Streptococcus Thermophilus* Dalam Pengolahan Yoghurt yang Berkualitas. *J. Sains Dasar*, 8(1), 13 - 19

Hidayat, Kusrahayu, Mulyani. (2013). Total bakteri Asam Laktat, Nilai pH dan Sifat Organoleptik Drink Yoghurt dari Susu Sapi yang Diperkaya dengan Ekstrak Buah Mangga. *Animal Agriculture Journal*, (1), 160-167.

Ikeda, D. M., Weinert E., Chang K. C., McGinn J. M., Miller S. A., Keliihoomalu, C. & DuPonte, M. W. (2013). Natural farming: lactic acid bacteria. *Sustain Agric*, 8, 3-4.

Kalista, A., Redjo, A., & Rosidah, U. (2018). Analisis Organoleptik (*Scoring Test*) Tingkat Kesegaran Ikan Nila Selama Penyimpanan. *Jurnal Fishtech*, *7*(1), 98-103.

Leesmith, J. (2005). *General Microbiology Laboratory*. Kasetsart University Publishing.

Lestary, S. (2011). Pengaruh Konsentrasi Belimbing Wuluh Terhadap Populasi Mikroba Pada Filet Nila Merah Dalam Penyimpanan Suhu Rendah. *Skripsi*. Fakultas Perikanan dan Ilmu Kelautan. Universitas Padjadjaran. Bandung

Moeljanto. (1992). *Pengawetan dan Pengolahan Hasil Perikanan.* Jakarta: Penebar Swadaya.

Munandar. (2009). *Kemunduran Mutu Ikan Nila pada Penyimpanan Suhu Rendah.* Serang: Universitas Sultan Ageng Tirtayasa.

Nadia, L. S., Surahman, & Adi, S. (2020). Pengaruh Penambahan Ekstrak Bunga Telang (*Clitoria ternatea*) terhadap Pertumbuhan Bakteri Asam Laktat pada Pembuatan Yogurt Telang. *Journal of Food and Culinary*, 3(1), 10- 17.

Parija, S. C. (2012). *Microbiology Immunology (2nd ed.).* India: Elsevier.

Pratama, A., Febriani, R. N., & Gunawan, S. (2013). Pengaruh Ragi Roti, Ragi Tempe dan Lactobacillus Plantarum terhadap Total Asam Laktat Dan pH Pada Fermentasi Singkong. *Jurnal Teknik ITS*, 2 (1), 90-93.

Prescott, L. M., Harley J. P. & Klein D. A. (2005). *Microbiology. Sixth Edition.* New York. Inc: McGraw-Hill Companies. 492-493, 910.

Rustan, R. I. (2013). Studi Isolasi dan Identifikasi Bakteri Asam Laktat dari Fermentasi Cabai Rawit (*Capsicum frutencens L.). Skripsi*. Program Studi Teknologi Hasil Ternak Jurusan Produk Ternak Fakultas Peternakan Universitas Hasanuddin Makassar.

Samsuri, M., Gozam, M., Mardias, R., Baiquni, M., Hermansyah, H., Wijanarko, A., Prasetya, B, & Nasikin, M. (2007). Pemanfaatan sellulosa bagas untuk produksi ethanol melalui sakarifikasi dan fermentasi serentak dengan enzim xilanase. *Jurnal Makara Teknologi, 11*(1), 17-24.

Santoso, B. (2017). *Budidaya Ikan Nila*. Yogyakarta: Kanisius.

SNI 2696-2020. (2020). Filet *Ikan Beku. Standar Nasional Indonesia*. Badan Standarisasi Nasional (BSN). Jakarta.

Sopandi, T. & Wardah. (2014). *Mikrobiologi Pangan.* C.V. Yogyakarta: Andi Offset,

Supardi & Sukamto. (1999). *Mikrobiologi Dalam Pengolahan dan Keamanan Pangan.* Bandung.

Suprihatin. (2010). *Teknologi Fermentasi.* Surabaya: UNESA University Press.

Suryaningsih, L., Hidayat, R., Lara Utama, G., Pratama, A., & Balia, R. L. (2019). *Effect of Lactic Acid Bacteria and Yeasts towards Chemical, Physical and Organoleptic Qualities of Mutton Salami,* 9(3), 829-834.

Taufiq, A., Lestari, M., & Prasetyo, S. (2015). Nutritional benefits of fish fillets: Protein and fat content. *Journal of Seafood Science*, *12*(3), 225-235.

Watanabe, M., Makino, M., Kaku, N., Koyama, M., Nakamura K., & Sasano, K. (2013). Fermentative L-(Þ)-Lactic Acid Production From Non-Sterilized Rice Washing Drainage Containing Rice Bran By A Newly Isolated Lactic Acid Bacteria Without Any Additions Of Nutrients. *Journal of Bioscience and Bioengineering*, 115(4), 449-452.

Wibowo, M. S. (2012). *Pertumbuhan Bakteri dan Kontrol Bakteri.* Yogyakarta: Gajah Mada University Press..

Windiyasari, R. (2011). Aplikasi Larutan Lidah Buaya terhadap Karakteristik Organoleptik Filet Nila Merah pada Penyimpanan Suhu Rendah. *Skripsi*. Fakultas Perikanan dan Ilmu Kelautan. Universitas Padjadjaran

Yuliana, G., Afrianto, E., & Pratama, I, R. (2015). Aplikasi Kombinasi Bakteri Asam Laktat, Natrium Klorida Dan Natrium Asetat Terhadap Masa Simpan Ikan Patin *(Pangasius hypophtalmu*s) Pada Suhu Rendah. *Jurnal Perikanan Kelautan*, 6(2), 85–90.

Zhang, L., Li, X., Lu, W., Shen, H., & Luo, Y. (2011). Quality Predictive Models of Grass Carp (*Ctenopharyngodon Idellus*) at Different Temperatures during Storage. *Food Control*, 22(8), 1197–1202.