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USE OF CAVENDISH BANANA PEEL FERMENTATION SOLUTION AND VINEGAR ON THE SHELF LIFE OF RED TILAPIA FILLETS AT LOW TEMPERATURE STORAGE BASED ON ORGANOLEPTIC CHARACTERISTICS

Penggunaan Larutan Fermentasi Kulit Pisang Cavendish dan Cuka Terhadap Masa Simpan Filet Nila Merah pada Penyimpanan Suhu Rendah Berdasarkan Karakteristik Organoleptik

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ABSTRACT

Red tilapia is a fish that has the potential to be used as raw material for filets but has a drawback, namely that filets cannot maintain their freshness for a long time because filets no longer have natural defenses, making it easier for spoilage microbes to reproduce more quickly. Therefore, effective preservation techniques are needed to extend the shelf life of fish without reducing organoleptic quality. The preservation technique that can be used is low temperature preservation with a combination of natural preservatives in the form of using a fermented cavendish banana peel solution. The aim of this research is to analyze the best vinegar concentration in the fermented solution of cavendish banana peels to extend the shelf life of red tilapia fillets based on organoleptic characteristics during low temperature storage. The research method used in this research is an experimental method. Red tilapia filets were treated with soaking in a fermented cavendish banana peel solution with the addition of 0%, 0.5%, 1%, 1.5% and 2% vinegar concentrations and then stored at low temperature (5°-10°C). The results of the research showed that the administration of banana peel fermentation solution had an influence on the shelf life of red tilapia fillets as seen from organoleptic characteristics. Providing a banana peel fermentation solution with the addition of 1.5% vinegar concentration is the best treatment in maintaining the freshness of red tilapia fillets until the 11th day of cold storage.

Keywords: Cavendish Banana Peel Fermentation, Low Temperature Storage, Organoleptic Testing, Red Tilapia Filet

ABSTRAK

Ikan nila merah memiliki kemampuan untuk dijadikan bahan baku filet tetapi memiliki kekurangan yaitu filet tidak bisa mempertahankan kesegarannya dalam waktu yang lama karena telah kehilangan sistem pertahanan alaminya sehingga memudahkan mikroba pembusuk berkembang biak lebih cepat. Oleh karena itu, diperlukan teknik pengawetan yang

efektif untuk memperpanjang masa simpan ikan tanpa mengurangi kualitas organoleptik. Teknik pengawetan yang dapat digunakan adalah pengawetan suhu rendah dengan kombinasi pengawet alami berupa penggunaan larutan fermentasi kulit pisang cavendish. Tujuan penelitian ini adalah menganalisis konsentrasi cuka terbaik pada larutan fermentasi kulit pisang cavendish dalam upaya memperpanjang masa simpan filet ikan nila merah Berdasarkan karakteristik organoleptik selama penyimpanan suhu rendah. Metode yang diterapkan dalam penelitian ini adalah metode eksperimental. Perlakuan dilakukan dengan merendam filet ikan nila merah dalam larutan fermentasi kulit pisang Cavendish yang mengandung cuka dengan variasi konsentrasi 0%, 0,5%, 1%, 1,5%, dan 2%, selanjutnya disimpan pada suhu 5–10°C. Hasil penelitian, menunjukkan bahwa pemberian larutan fermentasi kulit pisang memberikan pengaruh terhadap masa simpan filet nila merah yang dilihat dari karakteristik organoleptik. Pemberian larutan fermentasi kulit pisang dengan penambahan kosentrasi cuka 1,5% merupakan perlakuan paling efektif dalam menjaga kesegaran filet nila merah hingga hari ke-11 pada penyimpanan suhu rendah.

Kata Kunci: Filet Nila Merah, Fermentasi Kulit Pisang Cavendish, Penyimpanan Suhu Rendah, Pengujian Organoleptik

INTRODUCTION

As a source of animal protein, fish contributes significantly to meeting human nutritional needs. Red tilapia (*Oreochromis niloticus*) is a popular freshwater fish species and is highly sought after in Indonesia. Red tilapia has the potential to be filleted due to its thick flesh, few bones, and pure white flesh color, similar to red snapper (Djazuli, 2002). Despite its various advantages, fillets cannot maintain freshness for long periods because they have lost their natural defense system, making it easier for spoilage microbes to multiply more rapidly (Afrianto & Liviawati, 2010). Fish freshness plays a crucial role in determining the quality and shelf life of processed products (Wibowo et al., 2014; Suprayitno, 2020). The main factors causing fish quality decline are the activity of enzymes, chemicals, and bacteria that are sensitive to temperature changes. Improper handling after catching can cause fish freshness to decrease and impact product quality. This decline can be observed through changes in organoleptic properties such as appearance, aroma, taste, and texture (Nurqaderianie et al., 2016).

Storing red tilapia fillets at low temperatures can reduce metabolic activity and suppress microbial growth. Low temperatures also play a role in suppressing the possibility of chemical reactions and reducing water loss in food (Muchtadi & Sugiyono, 2013). Refrigeration is an economical and relatively safe preservation method, but it has several drawbacks, such as the potential for meat spoilage by psychrophilic bacteria, which can grow at temperatures between 0°C and 5°C and cannot completely halt biochemical processes that lead to quality degradation. Therefore, effective preservation techniques are needed to extend the shelf life of fish without compromising organoleptic quality.

The use of natural ingredients in fish preservation is an interesting alternative to explore. Concerns about the use of synthetic chemicals that can have harmful effects on health and the environment require natural alternatives, one of which is Cavendish banana peel, which has potential as a preservative. Banana peels are agricultural waste rich in carbohydrates, namely 59.51-76.58 (Essien et al., 2005; Lee et al., 2010; Emaga et al., 2007) so they can be used as a growing medium for LAB which can inhibit the growth of spoilage bacteria. Lactic acid fermentation can increase shelf life because the lactic acid produced by lactic acid bacteria can lower the pH of food ingredients.

One indicator of successful fermentation is the acidity level, or pH. Correct pH is crucial in the fermentation process because the microorganisms involved are sensitive to changes in

environmental pH. The quality and quantity of fermentation products are affected by acidity levels, where a pH that is too low (acidic) or too high (alkaline) can cause microbial cell death (Cika et al., 2022). Vinegar helps maintain the acidity level necessary for lactic acid bacteria growth at pH 4-5, allowing them to thrive optimally. Vinegar can be used as a fermentation control agent because its acidic properties can lower the pH of the fermentation environment, making it suitable for lactic acid bacteria growth. Vinegar can be used to enhance flavor, enhance flavor, and preserve food (Afrianti, 2013).

The purpose of this study was to analyze the best vinegar concentration in Cavendish banana peel fermentation solution to extend the shelf life of red tilapia fillets based on organoleptic characteristics during low-temperature storage. The organoleptic characteristics assessed included appearance, mucus, aroma, and texture, which are key indicators in assessing the quality and acceptability of fish products by consumers. This research is expected to contribute information for the development of fish preservation technology that is safe for consumption and environmentally friendly.

METHODS

Time and Location

The research was conducted from January to February 2024. The fish acclimatization process took place at the Aquaculture Laboratory, Faculty of Fisheries and Marine Sciences, Padjadjaran University. Research activities, including filleting and storage, were conducted at the Fisheries Product Processing Technology Laboratory, while organoleptic testing was conducted at the Biotechnology Laboratory, Faculty of Fisheries and Marine Sciences, Padjadjaran University.

Tools and Materials

The main materials used in the research included Cavendish banana peels, red tilapia, vinegar, and distilled water. The main tools used during the research included knives, cutting boards, scales, jars, measuring cups, tongs, cling wrap, and spatulas.

Research Parameters

The research parameters observed included appearance, mucus, aroma, and texture. Appearance was assessed based on the color and surface condition of the sample, mucus based on its presence and thickness, aroma based on the characteristic odor of the material, and texture based on the firmness and elasticity of the meat.

Research Methods

This study was conducted using an experimental method involving five treatments and analyzed in duplicate. The treatment consisted of soaking red tilapia fillets in a Cavendish banana peel fermentation solution with varying vinegar concentrations. The concentrations varied: 0% vinegar, 0.5% vinegar, 1% vinegar, 1.5% vinegar, and 2%. The baseline for determining the treatment dosage in this study refers to Nisah et al. (2021), who demonstrated the best results with a 3% vinegar solution. Based on preliminary research conducted with variations in vinegar additions of 1%, 2%, 3%, 4%, and 5% in Cavendish banana peel fermentation, the optimal fermentation time was 5 days and the optimal vinegar concentration was 1%, indicated by the highest lactic acid bacteria count. The fermentation solution was then applied to red tilapia fillets by soaking them for 30 minutes (Nisah et al., 2021). The fillets, soaked in the fermentation solution, were then stored at low temperatures (5o-10oC). The test parameters were as follows: Testing was conducted on days 1, 4, 6, 7, 8, 9, 10, 11, and 12.

Research Procedure

Equipment Sterilization

The sterilization method used was wet sterilization. Wet sterilization is performed using an autoclave that operates with pressurized steam (Misra & Misra, 2012). This method is commonly used to sterilize media, fluids, and laboratory equipment. The temperature and pressure typically used are 121°C at 15 psi, with a sterilization time ranging from 10 to 15 minutes (Gupta & Shukshith, 2016). These conditions are effective in inactivating bacteria and fungal spores (Ikenganyia et al., 2017).

Fermentation

150 grams of banana peels were cut into small pieces and washed, then weighed and placed in a jar. 500 ml of distilled water was added. Variations in vinegar concentrations of 0%, 0.5%, 1%, 1.5%, and 2% of the banana peel weight were added. The jar was tightly closed and covered with plastic wrap. The mixture was fermented for 5 days, then filtered and ready for use.

Making Red Tilapia Fillets

The fish were immobilized by placing them in a container filled with ice cubes until the water temperature reached 18-20°C. The red tilapia were then killed by a cold treatment. The fish died after 30 minutes (Liviawaty, 1999). After the fish were killed, they were scaled and washed with water. The back of the head and the base of the tail were incised, then the flesh was sliced from the head to the base of the tail parallel to the spine along the dorsal fin, forming an angle at the ribs. The fish fillets are then opened and incised down to the belly. The final step is to wash the finished red tilapia fillets in cold water.

Red Tilapia Fillet Soaking Process

Red tilapia fillets, washed in cold water and drained, are soaked in a fermented banana peel solution for 30 minutes. The fish fillets are then drained and placed on plastic sheets lined with a food liquid absorbent and wrapped in plastic wrap. The fillets are stored at a refrigerator temperature of 5-10°C.

Data Analysis

Organoleptic quality evaluation was conducted by five trained panelists. The parameters assessed were surface mucus, color and appearance of the meat, aroma, and texture. Organoleptic testing is a testing method that utilizes the five human senses as the primary means of evaluating the quality of fresh fish and intact fishery products (Wahyu et al., 2019). The organoleptic assessment results were then analyzed using a non-parametric method, the Friedman test, to determine the panelists' level of preference for organoleptic characteristics. According to Daniel (1989), if the Friedman test results show a significant difference, then it is continued with a multiple comparison test using the Bayes method by considering the criteria weights and median values.

RESULTS

Appearance

Organoleptic testing of appearance is one of the main factors influencing the quality of a food product. Meat is the main parameter in determining the quality of fish freshness (Masengi et al., 2021). Appearance is one of the factors that determines consumer acceptance of a product. The results of the organoleptic analysis of the appearance of red tilapia fillets during low-temperature storage are listed in Table 1.

Table 1. Median and Average Values of Appearance of Red Tilapia Fillets on Day 9 Based on the Treatment of Soaking in Banana Peel Fermentation Solution and Vinegar During Low-Temperature Storage (5-10°C)

Concentration (%)	Median	Average
0	3	2.2[a]
0.5	3	3.4[a]
1	5	4.2[a]
1.5	5	5[a]
2	5	4.6[a]

Mucus

According to Pariansyah et al. (2018), the appearance of mucus indicates the beginning of the quality deterioration process or the prerigor phase. The mucus in fish meat is significantly related to the quality of the fish fillet. Thin, transparent, and slippery mucus usually indicates that the fish is still fresh. Conversely, thick, cloudy, and sticky mucus indicates that the fish has lost its freshness. The results of organoleptic tests of mucus on red tilapia fillets during cold storage are presented in Table 2.

Table 2. Median and Average Values of Red Tilapia Fillet Mucus on Day 9 Based on Treatments of Soaking in Banana Peel Fermentation Solution and Vinegar During Low-Temperature Storage (5-10°C)

Concentration (%)	Median	Average
0	3	2.2[a]
0.5	5	3.8[a]
1	5	4.2[a]
1.5	5	5[a]
2	5	4.6[a]

Aroma

Aroma is a determining indicator for assessing fish freshness. Junianto (2003) stated that low glycogen levels in fish cause rigor mortis to occur more quickly, making the fish more susceptible to foul odors. The results of organoleptic observations on the aroma of red tilapia fillets during low-temperature storage are presented in Table 3.

Table 3. Median and Average Values of Aroma of Red Tilapia Fillets on Day 9 Based on the Treatment of Soaking in Banana Peel Fermentation Solution and Vinegar During Low-Temperature Storage (5-10°C)

Concentration (%)	Median	Average
0	3	2.2[a]
0.5	3	3.4[a]
1	3	3.4[a]
1.5	5	5.8[b]
2	3	3.8[ab]

Texture

Texture is an important factor influencing consumer preference for food products. This property consists of a number of physical characteristics resulting from the structure of the food and can be directly perceived (Lokollo et al., 2020). In storing fresh products such as fish, texture is an important parameter for determining freshness (Dewi et al., 2023). The quality of

fish texture is influenced by several factors, including the storage method. The average values for the texture parameters of salted fish are presented in Table 4.

Table 4. Median and Average Values of Red Tilapia Fillet Texture on Day 9 Based on the Treatment of Soaking in Banana Peel Fermentation Solution and Vinegar During Low-Temperature Storage (5-10°C)

Concentration (%)	Median	Average
0	3	1.8[a]
0.5	3	3[a]
1	3	3.8[a]
1.5	5	5.4[b]
2	5	4.2[ab]

DISCUSSION

Appearance

The results of the Friedman test at a 5% significance level indicated that red tilapia fillets soaked in Cavendish banana peel fermentation solutions with different vinegar concentrations produced no significant differences in appearance characteristics. The color of the red tilapia fillets after soaking in Cavendish banana peel fermentation solutions with different vinegar concentrations did not differ from each other. On the first day of storage, all treatments showed the same median appearance value, namely 9. This median of 9 is the highest value, indicating that the tilapia fillets still retained their characteristic color and appeared bright. The freshness of red tilapia fillets decreased with storage. Red tilapia fillets had the highest freshness level on the first day because no decay processes had occurred that could alter the appearance parameters leading to quality degradation. As storage period increased, the red tilapia fillet flesh became dull and lackluster, with a yellowish tinge on the edges of the fillets.

Water loss, or the hydration process in fish, can make the meat texture tougher, appear dull, and wrinkled, thus reducing its appearance (Naiu et al., 2023). Widyasari (2006) states that both physical and chemical changes can occur during storage. Meanwhile, according to Rachmawati et al. (2016), the decline in appearance is caused by the activity of microorganisms that break down proteins and convert myoglobin to metmyoglobin, resulting in a dull and less attractive appearance on the meat surface. Loppies et al. (2021) also add that myoglobin is the main pigment in meat that plays a crucial role in changing the color of fish.

The acceptance limit for red tilapia fillets soaked in Cavendish banana peel fermentation solution with different vinegar concentrations based on appearance values at 0% vinegar concentration has a shelf life of up to 7 days, 0.5% vinegar concentration has a shelf life of up to 8 days, 1% and 2% vinegar concentrations have a shelf life of up to 9 days, and 1.5% vinegar concentration has a shelf life of up to 10 days. This acceptance limit is seen from the minimum organoleptic value quality requirements for fresh fish fillets in low-temperature storage, which is 5 (Insani et al., 2021). In organoleptic testing, a value of 5 describes the condition of white meat with a slight pink hue, appearing slightly dull but still quite bright, and there are blood stains on the reddish-brown lateral line. The best treatment is the red tilapia fillet soaking with the addition of 1.5% vinegar concentration due to the highest average value among the other treatments. While the treatment with the lowest appearance value is the soaking of the fermentation solution without the addition of vinegar (0% concentration).

Mucus

The results of the Friedman test at a significance level of 5% indicated that red tilapia fillets soaked in Cavendish banana peel fermentation solutions with different vinegar concentrations produced mucus characteristics that were not significantly different. The

acceptance limit for red tilapia fillets soaked in Cavendish banana peel fermentation solutions with different vinegar concentrations was determined by their appearance. The 0% vinegar concentration had a shelf life of up to 8 days, while the 0.5%, 1%, and 2% vinegar concentrations had a shelf life of up to 9 days, and the 1.5% vinegar concentration had a shelf life of up to 10 days. The best treatment, based on the organoleptic characteristics of mucus, was the 1.5% vinegar concentration treatment, as it maintained the mucus value the longest, up to 10 days, with the highest average value of 5. The acceptance limit for red tilapia fillets soaked in Cavendish banana peel fermentation solutions with different vinegar concentrations showed a thin, slightly thick or slightly sticky, and somewhat transparent (somewhat clear) mucus.

As the shelf life increases, the mucus becomes thicker and more visible on the red tilapia fillets. The appearance of mucus is the result of advanced biochemical processes and the growth of microorganisms (Dewi et al., 2023). Fish spoilage can be caused by the presence of fish mucus, which occurs during the hyperemia stage. At this stage, the mucus is secreted from glands in the skin and forms a thick, transparent layer that covers the fish's body, providing a suitable environment for bacterial growth (Litaay et al., 2017). Delays in handling can accelerate bacterial growth, causing the fish to decay, characterized by the appearance of mucus on the surface of the body, a softened flesh texture, and a foul aroma due to the formation of compounds such as indole, skatole, mercaptan, ammonia, and sulfide acid (Husni & Putra, 2015).

Aroma

Friedman test results at a 5% significance level indicate that red tilapia fillets soaked in Cavendish banana peel fermentation solution with different vinegar concentrations produced significantly different and non-significantly different aroma characteristics. The results showed that soaking in a fermented Cavendish banana peel solution with vinegar concentrations of 0%, 0.5%, 1%, and 2% did not significantly differ. Treatments with vinegar concentrations of 1.5% and 2% did not show any significant differences. The treatment with a vinegar concentration of 1.5% was significantly different from the treatments with concentrations of 0%, 0.5%, and 1%.

The acceptance limit of red tilapia fillets soaked in a fermented Cavendish banana peel solution with different vinegar concentrations was based on aroma values. The 0% vinegar concentration had a shelf life of up to 8 days, the 0.5% and 1% vinegar concentrations had a shelf life of up to 9 days, the 1.5% vinegar concentration had a shelf life of up to 11 days, and the 2% vinegar concentration had a shelf life of up to 10 days. Based on the median and average aroma values, it can be concluded that soaking tilapia fillets in a fermented Cavendish banana peel solution with a vinegar concentration of 1.5% and storing at low temperature was the most effective treatment. This was demonstrated by the 1.5% concentration, which had the highest average value of 5.8, with a median value of 5 (meeting the requirements for consumption), and a longer acceptance limit compared to other treatments, up to day 11. A median value of 5 indicates a somewhat fresh aroma in the tilapia fillets, with the characteristic odor disappearing but no distinct odor yet detected. Fermenting Cavendish banana peels with the addition of different vinegar concentrations can grow lactic acid bacteria (LAB), which have the ability to inhibit spoilage-causing bacteria. LAB produces organic acids, particularly lactic acid, which can lower the environmental pH, inhibiting the growth of spoilage bacteria because most species cannot survive in acidic pH conditions (Nadia et al., 2020).

The aroma value of fish fillets decreased significantly with increasing storage time. Red tilapia fillets, which initially had a fresh aroma, gradually decreased until they became less fresh, began to smell different, and finally acquired a foul odor. Increasing storage time caused changes in aroma, with the smell of ammonia and a slight sourness. The ammonia odor is a

byproduct of the protein decomposition process by bacterial activity, so that the increase in bacterial numbers is directly proportional to the level of ammonia produced (Saimima et al., 2021). According to Oyelese (2006), putrefactive bacteria that break down fat and protein will produce compounds such as ammonia, indole, and hydrogen sulfide (H_2S), which are undesirable because they can cause an unpleasant odor and an unpleasant taste in fish. One factor that accelerates the appearance of a foul odor in fish is low glycogen levels, which causes the process of rigor mortis to occur quickly (Syamsir, 2008).

Texture

The results of the Friedman test at the 5% level indicated that red tilapia fillets soaked in Cavendish banana peel fermentation solution with different vinegar concentrations produced significantly different texture characteristics. The results showed that soaking in Cavendish banana peel fermentation solution with vinegar concentrations of 0%, 0.5%, 1%, and 2% did not significantly differ. Treatments with vinegar concentrations of 1.5% and 2% did not show any significant differences. The treatment with vinegar concentrations of 1.5% was significantly different from the treatments with vinegar concentrations of 0%, 0.5%, and 1%.

The acceptance limit for red tilapia fillets soaked in Cavendish banana peel fermentation solution with different vinegar concentrations was determined based on appearance values. The 0% vinegar concentration had a shelf life of up to 7 days, the 0.5% and 1% vinegar concentrations had a shelf life of up to 8 days, and the 1.5% and 2% vinegar concentrations had a shelf life of up to 10 days. Based on the median and average texture values, it can be concluded that tilapia fillets soaked in a fermented Cavendish banana peel solution plus a 1.5% vinegar concentration and stored at low temperature were the most effective treatment. This was demonstrated by the 1.5% concentration having the highest average value of 5.4, with a median value of 5 (meeting the requirements for consumption), and a longer shelf life compared to the other treatments, up to day 9. The median value of 5 indicates the fillets had a slightly soft and somewhat chewy texture.

This is a result of muscle softening caused by connective tissue disintegration over time. The organoleptic value of fish texture decreased with increasing storage time. The textural changes are characterized by increasingly soft flesh, leaving a mark when pressed, and easily detaching from the spine (Litaay et al., 2017). Textural changes in fish meat are caused by enzymatic processes that begin to decompose muscle tissue, resulting from the cessation of blood circulation, which supplies oxygen needed for metabolism (Maiola et al., 2020). As time passes after a fish dies, its muscle tissue stiffens, a process known as rigor mortis. According to Pradana (2008), during the final stages of decomposition, fish muscles soften again and lose their elasticity (post-rigor phase) due to uncontrolled enzyme and bacterial activity, which causes the breakdown of muscle proteins.

CONCLUSION

The addition of a banana peel fermentation solution with added vinegar concentration affected the shelf life of red tilapia fillets, as seen from the organoleptic characteristics. The addition of a banana peel fermentation solution with a 1.5% vinegar concentration was the best treatment in maintaining the freshness of red tilapia fillets until the 11th day of low-temperature storage.

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